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ABSTRACT

This manual, published by the Illinois Association of School Boards, was designed to be used as a teaching tool and reference source for overseeing effective school maintenance. Section 1 describes the basics of good school maintenance, including managing the program, using computers, controlling energy costs, ensuring safe practices, designing buildings for efficient maintenance, and being informed about environmental issues. Section 2 details guidelines for operating cleaning and general building services, such as custodial operations, area cleaning programs, and equipment and supplies. A custodian's glossary is included. The third section provides guidelines for building maintenance, specifically, caring for the exterior and roof. Procedures for maintaining school grounds are detailed in the fourth section. The fifth section describes the maintenance of mechanical equipment, including heating and air conditioning systems, sanitary systems and fixtures, sewage treatment plants, and electrical systems. A management tools appendix contains a list of environmental resources; sections on cleaning and general building services, grounds maintenance, and mechanical equipment; and annual inspection checklists. (LMI)

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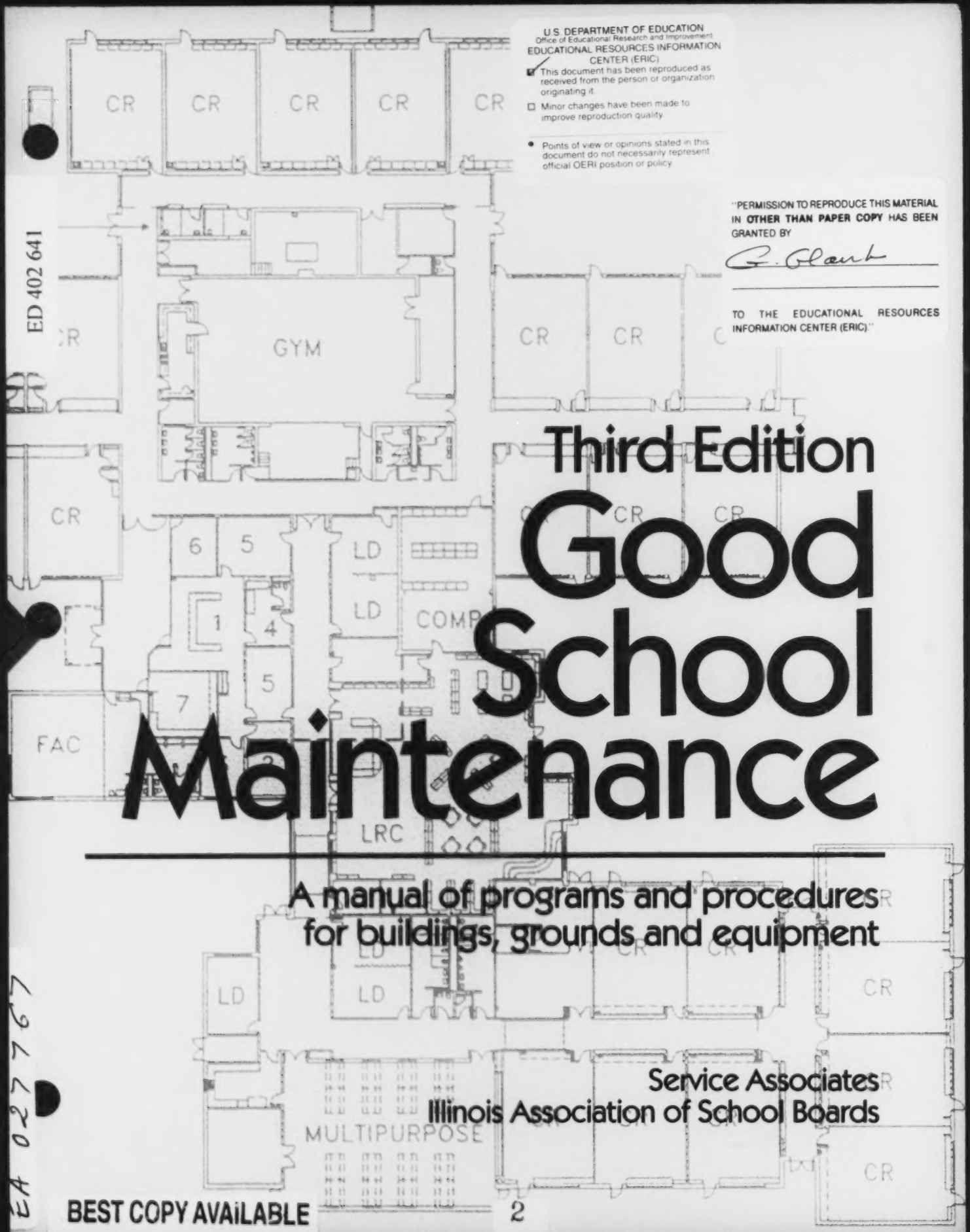

Third Edition
Good School Maintenance

A manual of programs and procedures for buildings, grounds and equipment

Service Associates
Illinois Association of School Boards

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EA 027 697

Third Edition

Good School Maintenance

Special Acknowledgements

Good School Maintenance is the product of many people. Authors and other contributors are listed with their individual chapters throughout the manual. In addition, the Illinois Association of School Boards is indebted to a number of other individuals and firms for making the manual possible. Listed alphabetically, they include the following:

Glen L. Bellows, President of Buchanan, Bellows and Associates, Ltd., Bloomington, IL, supervised updating of chapters on HVAC, sanitary systems, sewage treatment, electrical, and energy conservation.

William C. Bradley, of C & W Bradley, P.C., Rockford, IL., produced a new chapter for the Third Edition on environmental issues and applied his knowledge of the topic to the custodial sections, as well.

Jack T. Harroun served as senior editor of the first two editions of *Good School Maintenance*. Although retired from the University of Illinois and not directly involved in the Third Edition updating, his numerous contributions include the ingenious design of the custodial sections on cleaning programs, procedures and equipment.

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Good School Maintenance

A manual of programs and procedures for buildings • grounds • equipment

written and edited by:

Service Associates
Illinois Association of School Boards

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Cautionary Note

Good School Maintenance is intended as a general guide in the development of sound policies and procedures for the care of school buildings, grounds and equipment. Local policies and procedures must be tailored to specific needs and be based upon requirements of the equipment and supplies in use. Specific instructions often must be obtained from an appropriate equipment manufacturer or other qualified source.

The Illinois Association of School Boards, as well as the individual authors and editors and their employing firms, disclaim any liability or responsibility for the use or misuse of information contained in *Good School Maintenance.*

Uses of Content

Users of *Good School Maintenance* are authorized to adapt policies and procedures in any manner necessary to make them acceptable for local requirements and to aid in the development of a local custodial manual. Forms in the Appendix may be copied with or without modification for use by the purchasing school district.

Forms and other materials in this manual may not be copied for purposes of re-sale or distribution to other institutions or individuals.

April, 1996

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A word about Good School Maintenance

A major aim of IASB Service Associates is to call attention to the need for the sensible care of school buildings, grounds and equipment. A second aim is to provide any help school officials may need in implementing maintenance programs. These two purposes led to the development of *Good School Maintenance.*

The manual itself is designed to fill two distinct needs in school maintenance:

1) The manual is intended as a basic training tool. It can be used as a text or resource in training new maintenance staff members. Members of the maintenance staff can use it to refresh their knowledge—in effect, to train themselves. The manual is probably best viewed as one tool in a larger, continuing program of staff development.

2) The manual also is intended as a reference source. It covers most routine tasks and problems encountered in school sanitation and maintenance. The maintenance staff member who is stumped for an answer may well find it in this manual.

As both a training tool and a reference source, this manual should prove useful to the maintenance manager as well as to the staff trainee.

The Third Edition

The beginning of *Good School Maintenance* dates back to 1964 when IASB Service Associates published the first section to the *Planned Maintenance Manual.* Over the years, that manual—published in a ring binder—grew in size and complexity. It was finally decided in 1973 to begin from scratch—to totally re-evaluate, re-plan and re-publish the manual in book form.

The first edition of *Good School Maintenance* appeared in 1976 with material updated and expanded from the original ring binder. The book included a new section on sanitation by Jack T. Harroun, of the University of Illinois, who served as Senior Editor through the first two editions. The success of *Good School Maintenance* exceeded all expectations, so that by 1982 plans were underway to expand and up-date the book.

A Second Edition, entitled *The NEW Good School Maintenance*, was published in 1984 and reprinted in 1987. The section on Cleaning and General Building Services was expanded from two chapters to seven and provided an innovative guide to custodial operations that remains intact with the Third Edition.

In Chapter Eight, the school is divided into 13 areas that need cleaning, and each area cleaning program (such as for classrooms) cites detailed procedures for specific tasks (such as dusting or sweeping) that are found in Chapter Nine.

The Third Edition of *Good School Maintenance* also contains a new chapter on environmental issues and all other chapters have been carefully reviewed and updated.

Role of Service Associates

Good School Maintenance is made possible by the IASB Service Associates, who donated untold hours to its development. Service Associates consist of firms that do business with schools and are invited to become members based upon their reputations for honesty and integrity. (A complete list of current Service Associate members appears in each issue of *Illinois School Board Journal.*)

We sincerely hope that this manual will prove helpful in stimulating and supporting effective school maintenance. We remain eager to obtain suggestions and criticisms of this manual to aid in making future improvements.

Wayne L. Sampson
Executive Director
Illinois Association of School Boards
April, 1996

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Section ONE

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1 / Managing a School Maintenance Program

Management means getting things done through other people. It requires coordination of manpower, machinery and materials with specific purposes in mind.

Management also means getting the best results possible with available resources.

Because school budgets are seldom adequate to satisfy all desires, school boards and administrators establish priorities. The maintenance manager, therefore, must ensure that physical plant upkeep enjoys adequate status among budget-setting priorities. Then he must set goals and plan carefully to obtain best results from the resources that are made available. Among other things, this means determining standards of cleanliness and upkeep that are both acceptable and attainable.

Upkeep of the physical plant requires the support of the entire school community—students, staff, administration and school board—but it is the maintenance manager who is responsible for developing budgets and programs and seeing that they are carried out.

Some basic elements of an effective management program are as follows:

Policy and Division of Responsibility

The school board should develop a written, general policy outlining the overall goals of the maintenance program. The board should seek input from maintenance managers to make sure the goals are realistic.

The school administration, in cooperation with the maintenance manager, should develop written regulations outlining the responsibilities of all members of the school community in regard to the care and upkeep of buildings, grounds and equipment.

Planning

Effective planning must be based on carefully thought-out objectives and priorities. The manager must determine, in keeping with the school board's goals, what services are most important and how often they need to be performed. Three kinds of plans are needed:

Current plans include the daily and periodic scheduling of routine maintenance activities. They detail services to be accomplished, instructions on how these will be done, and controls to provide measurement of results.

Short-range plans generally cover a period of one or two years, and may include such items as major repairs or replacement of large equipment. Careful projection of large-ticket items is necessary so they may be included in budgets and time schedules.

Long-range plans will include large-scale construction or landscaping projects. They are formulated in conjunction with school administration and/or the school board, and frequently require outside technical assistance.

Organization

The purpose of organization is to obtain the maximum benefits for each dollar expended. Thus, the maintenance manager is constantly

Managing a School Maintenance Program was originally compiled from material supplied by Jack T. Harroun, University of Illinois (retired), and John T. Courson, of MOP Corporation. Third Edition update by John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School.

challenged to find better ways of doing things—either more results for the same cost or the same results at less cost.

The critical elements required to properly organize maintenance operations are:

Organization of work: Priorities must be established so the critical tasks receive attention first. Normally, these will be the services that are necessary to safeguard the health and safety of those using the facilities. The proper sequence of activities necessary to complete the tasks efficiently should be established.

Organization of people: Tools include an organization chart and job descriptions for all employees. These should show daily worker-hours available, broken down into the various skill classifications.

Organization of equipment and supplies: When materials needed to do a job are not available, time is wasted. The maintenance supervisor must plan for secure storage, proper use, and regular replacement of equipment and supplies.

A number of tools are helpful for organizing, including schedules of daily and periodic work, written work assignments, work reports, personnel evaluations and inspection reports. See the Management Tools Appendix in Section Six for tools that may be reproduced or adapted for local use.

Match-up and Assigning Work

The maintenance manager must constantly evaluate the maintenance workload in terms of time and skills required to complete the necessary tasks. The manager then allocates man-hours, materials, and skills to complete the assignments. This process is known as "match-up."

Before work is assigned, the maintenance manager should prepare batches of work, work orders, or individual work tasks. Each task should require a known amount of time for completion. When assigned a measured amount of work, the maintenance staff member should be informed of the expected rate of production and time of completion. Work assignments normally should be written.

Training and Evaluation

A regular program of training for maintenance staff should be established by policy. In addition to initial training for new workers, special training will be needed in the use of new products, equipment, and techniques. Continuing training scheduled on a regular basis is desirable to refresh and update skills.

To enhance on-the-job learning, as well as to monitor work being accomplished, two types of evaluations are needed: periodic evaluation of specific jobs and regular personnel evaluations. The latter are usually done annually, and the purpose should be to promote productivity and to identify any problems. See the Management Tools Appendix for sample forms.

Professionalism

The majority of maintenance employees want to do a good job, and when treated as professionals, will respond by displaying a professional attitude. The maintenance manager should strive to build a workforce that displays knowledge of the job, dependability, and a positive attitude toward the work and the organization. All members of the maintenance crew should be expected to take responsibility for effective, efficient use of time and materials.

It is the manager's responsibility to ensure that employees have the opportunity to function efficiently through proper organization, coordination of work, and follow-up. Professionalism can be fostered by involving the entire maintenance team in setting work objectives and planning schedules.

Management Responsibilities

The maintenance program manager has two overall areas of responsibility: to enable the maintenance team to function at maximum efficiency and to ensure that the goals and objectives of the maintenance program are being met with available resources.

To permit most effective functioning of employees, the manager must provide them with:

- An achievable goal
- A basis for gaining recognition
- A basis for measuring their own performance and progress
- A basis for developing pride and self esteem by knowing they have done a job within the guidelines set by management.

To ensure that satisfactory progress is being made toward goals and objectives and that tasks are completed at reasonable cost, the manager must keep records that reflect departmental per-

formance and progress. This follow-up must lead to the improved performance of individual employees as well as to improved planning and organizing.

This manual is intended to increase the efficiency of the maintenance team. Material in subsequent chapters emphasizes the importance of planning maintenance tasks and organizing and executing them in an efficient sequence. Particular attention is given to the planning and organizing of:

- Personnel
- Assignment of tasks
- Standards
- Time
- Procedures
- Equipment
- Costs

In summary, a well-managed maintenance program is based upon:

1) Carefully-defined, realistic goals and objectives.

2) Short-range and long-range plans for carrying out the objectives within resources available.

3) Organization of personnel and equipment for most efficient performance.

4) Regular training and evaluation of personnel and the fostering of a professional attitude among the maintenance team.

5) Monitoring and follow-up to ensure that progress is being made toward objectives.

2 / Using Computers in School Maintenance

Computers are popular in schools because they enhance teaching and learning and help administrators with a wide array of management tasks.

Computers also have found a home in the school physical plant where they perform a wide variety of functions and tasks. In fact, the computer's greatest contribution to efficiency in school management may prove to be its application to physical plant activities. These activities are diverse, involving everything from grounds maintenance to boiler maintenance to the control of heating/ventilating/air conditioning systems (HVAC). Though diverse, these activities are frequently the responsibility of a single manager—and their management can be handled more efficiently with a computer.

More and more schools are using computers to control physical plant operations and maintenance. Members of the maintenance team need a working grasp of how computers are being used in the system. Maintenance supervisors in schools that are not yet capitalizing fully on the contributions of computers also need to be aware of what these advanced technologies can do to help them. They should prepare themselves to capitalize on the opportunities when computers become available to them.

The management functions that computers typically improve for the maintenance supervisor include:

- scheduling the operation of the heating and cooling system;
- monitoring such critical factors as weather conditions, heating/cooling system functions, security, and fire safety measures;
- reporting on the condition of equipment, energy usage, and manpower usage.

COMPUTER SCHEDULING

Scheduling the start-up and shutdown of heating/cooling systems is always a challenge. The aim is to avoid uncomfortable students and teachers on the one hand and unnecessary energy consumption on the other. Holidays and unscheduled meetings add to the difficulty of balancing cost with comfort.

The solution is to connect the appropriate equipment to a computer that is programmed to manage scheduling problems. By feeding proper instructions to the computer, the supervisor keeps building occupants comfortable without running costly equipment all night or on weekends.

COMPUTER MONITORING

Has it ever happened that school had to be cancelled because a coil froze and there was water everywhere? Wouldn't it have been nice to have known this when the coil froze at 10:00 p.m. instead of at 5:00 a.m. when the custodian found the water?

A computer never sleeps and can monitor the status of critical equipment 24 hours a day, seven days a week. The computer can be programmed to take appropriate action when equipment failure is detected. For example:

Monitoring weather conditions—The

Using Computers in School Maintenance, original chapter by Jack T. Harroun, University of Illinois (retired). Third Edition review by Andrew P. Titus III, Barber-Colman Company.

```
HVAC  INFORMATION  LEVEL 1  INDEX

   NORT  LIBRARY                 CHM  CHEMISTRY
   BOT   BOTANY HALL             CPU  COMPUTER SCI
   PFF   POST OFFICE             CH1  CHILLER PLT
   PPT   PHYSICAL PLT
```

```
HVAC  INFORMATION  LEVEL 2  INDEX

 AC1 - AIR COND #1          AC2 - AIR COND #2
 FAN - SUPPLY FAN           EXH - EXHAUST FAN
```

```
HVAC  INFORMATION  LEVEL 3  INDEX

 FO1   EXHAUST FAN          ST1   SUPPLY TEMP
 FO2   SUPPLY FAN           DR1   NORTH EXIT
 DR2   EAST EXIT            HT1   ZONE 1 HEAT
 SM1   ZONE 1 SMOKE         HT2   ZONE 2 HEAT
 SM2   ZONE 2 SMOKE         HT3   ZONE 3 HEAT
 SM3   ZONE 3 SMOKE         HT4   ZONE 4 HEAT
 SM4   ZONE 4 SMOKE         SP1   SPACE TEMP    PAGE (_)
```

Figure 2-1—Information level index categorizing equipment by location (level 1 at top), type (level 2 at center) and function (level 3 at bottom).

computer can be set up to monitor the outside temperature and the presence of moisture to alert the staff to the need for snow removal. The computer can even be programmed to automatically call the supervisor at home if the situation occurs after working hours.

Monitoring heating/cooling systems—A computer can be programmed to react to just about any type of equipment condition. If an air conditioning coil begins to freeze, the computer can quickly alert the proper maintenance people. The computer will not prevent the problem, but it can detect it early and prevent equipment failure. The computer can be programmed to monitor the heating/cooling system and to give notification if equipment fails to start-up or shut-down.

Monitoring security—After-hours monitoring of security zones may be accomplished through the school computer. Connecting the computer to critical security points allows it to review the security status of critical zones within the school anytime of the day or night. The computer also can be programmed to take preventive action, once the critical security points are connected, such as automatically calling the police station or a staff member who knows what to do. The computer also can be set up to seal off doors and exits.

Monitoring fire safety—Fire safety is of critical concern in school buildings. The computer system can be set up to monitor critical areas within the school and, if a fire is discovered, to take the proper action. Actions that can be triggered by a computer include:

- announce alarms
- control dampers
- announce evacuation
- control elevators
- activate sprinklers
- report conditions to a central location, including a fire station.

All of these functions are critical to the proper management of a fire.

```
HVAC -     FIELD DATA POINTS   PGM DAY   2  MON  05 OCT 1995    09:30    PAGE :  1

FOR:CENT CENT PLANT     CH2  CHILLER 2
  CS   CHILLER          ON                  CHS  CHW SUP TEMP      42.0  F
  P3   CHW PUMP         ON                  CHR  CHW RET TEMP      51.7  F
  P4   CW PUMP          ON                  FLO  CHW FLOW         876.5  GPM

                              05 OCT 1995   09:30
```

Figure 2-2—Instantaneous equipment status report shows equipment type, location, function and current status.

TIME INTERVAL: 5

COL	SYS	LEVELI	LEVELII	LEVELIII	ENG	COL	SYS	LEVELI	LEVELII	LEVELIII	ENG
01	F	LIBR LIBRARY	SMK SMOKE DETECT	DS1 DUCT SMOKE		02	S	LIBR LIBRARY	MED MEDICAL WING	ED EAST DOOR	
03	H	CENT CENT PLANT	ELE ELECTRICAL	DMI DEMAND NTR 1	KW	04	H	CENT CENT PLANT	CH1 CHILLER 1	CHS CHW SUP TEMP	F
05	H	CENT CENT PLANT	CH1 CHILLER 1	CHR CHW RET TEMP	F	06	H	CENT CENT PLANT	CH1 CHILLER 1	CWS CW SUP TEMP	F
07	H	CENT CENT PLANT	CH1 CHILLER 1	CWR CW RET TEMP	F	08	H	GYM GYMNASIUM	AH1 AHU 1	SF SUPPLY FAN	
09	H	GYM GYMNASIUM	AH1 AHU 1	DAT DISCH TEMP	F	10	H	GYM GYMNASIUM	AH1 AHU 1	MAT MIX AIR TEMP	F
11	H	GYM GYMNASIUM	AH1 AHU 1	RAH RET AIR HUMD	% RH	12	H	GYM GYMNASIUM	AH1 AHU 1	RAT RET AIR TEMP	F

TL	TIME	1	2	3	4	5	6	7	8	9	10	11	12
				KW	F	F	F	F		F	F	% RH	F
2	12:01	NOR	NOR	8457.8	42.2	49.8	81.6	89.5	ON	65.5	56.9	51.7	66.9
2	12:06	NOR	NOR	8578.7	42.3	49.8	82.0	90.0	ON	65.5	55.3	53.3	67.2
2	12:11	NOR	NOR	8110.2	42.5	50.5	82.3	89.4	ON	65.5	55.3	52.8	67.2
2	12:16	NOR	NOR	7678.3	42.7	50.8	82.3	89.4	ON	65.1	56.2	55.1	67.2
2	12:21	NOR	NOR	8087.7	42.4	50.7	81.9	88.9	ON	65.7	56.2	55.1	68.3
2	12:26	NOR	NOR	8373.5	42.1	51.0	81.2	88.9	ON	64.9	57.3	52.3	68.3
2	12:31	NOR	NOR	8585.8	42.1	50.6	81.2	88.9	ON	64.0	56.1	51.1	68.3
2	12:36	NOR	NOR	8172.7	42.5	50.6	81.7	89.1	ON	64.0	58.0	51.1	68.3
2	12:41	NOR	NOR	8600.1	42.8	50.5	81.3	90.3	ON	65.3	57.1	50.7	68.3
2	12:46	NOR	NOR	8543.3	42.8	50.1	81.3	90.3	ON	66.5	57.1	49.2	67.3
2	12:51	NOR	NOR	8015.6	43.2	50.3	81.3	88.7	ON	66.8	56.3	50.1	68.7
2	12:56	NOR	NOR	8347.5	42.9	50.3	81.2	88.3	ON	65.7	55.2	50.9	68.1
2	13:01	NOR	NOR	8125.6	42.4	50.5	80.8	88.3	ON	66.0	55.9	52.3	67.8
2	13:06	NOR	NOR	7720.1	42.5	50.7	81.5	89.0	ON	64.5	55.9	51.4	68.4
2	13:11	NOR	NOR	7890.1	42.7	50.7	81.9	89.5	ON	64.5	57.1	52.0	67.1
2	13:16	NOR	NOR	8364.5	42.3	51.1	81.5	89.9	ON	66.1	57.9	51.7	66.9
2	13:21	NOR	NOR	8364.5	42.6	50.5	81.1	89.9	ON	65.4	56.7	51.1	67.7
2	13:26	NOR	NOR	8653.9	42.5	50.2	81.4	88.6	ON	64.8	56.7	50.3	67.7
2	13:31	NOR	NOR	8598.3	42.5	49.8	81.8	88.3	ON	64.8	55.9	50.9	68.0

Figure 2-3—Trend log with equipment status recorded at five-minute intervals.

COMPUTER REPORTING

A computer, of course, can store, manipulate, and report on masses of information. These capabilities enable the computer to function as a tool for reporting on the performance of the school's physical plant. Three kinds of physical plant information need to be stored, manipulated and reported: equipment, energy, and manpower.

Equipment reports—The computer will centralize all information about the heating/cooling equipment that is connected to the computer. The computer can then produce orderly reports on the current status of the equipment. *Figure 2-1* shows how the different equipment within a school may be categorized logically by location, type, and function. Once equipment is organized in this manner, the school's physical attributes can be efficiently evaluated with the instantaneous equipment status report shown in *Figure 2-2*.

In schools, problems often arise either after hours or when no one is around to observe. The school computer can log information at regular intervals and make it available for later evaluation. This type of reporting is termed "trend logging" and is illustrated in *Figure 2-3*. The trend log may be set up to print the current conditions of equipment every one, five, or ten minutes so a problem may be evaluated with the proper equipment information.

When set up to coordinate occupancy and equipment schedules, the computer must provide the supervisor with scheduling reports. *Figure 2-4* shows a weekly schedule for equipment operation, which can be compared with scheduled school activities for verification.

The school computer can be programmed to provide runtime information on the equipment connected to the computer. Such information, illustrated in *Figure 2-5*, is invaluable in planning preventive maintenance.

The summary of runtime allows maintenance staff to evaluate the level of maintenance required for each piece of equipment connected to the computer. The computer also can announce when a piece of equipment runs past its maintenance interval and requires immediate attention.

Energy reports—The common method for

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S	KEY 1	KEY 2	KEY 3	LEV 1	LEV 2	LEV 3	PARAMETERS	TIME	DAYS
H	STA			ADM	AH1	FAN		800	.23456..
H	STB			30	3	1		1700	12345678
H	STB			30	4	1		1700	12345678
H	STB			30	7	1		1700	12345678
H	STB			30	8	1		1700	12345678
H	STB			30	20	1		1700	12345678
H	STB			30	23	1		1700	12345678

Figure 2-4—Summary of scheduled equipment operation can be verified by comparing with scheduled school activities.

evaluating school energy usage is to examine utility bills. However, most bills do not show where energy is going. The computer can monitor and report energy usage by location and even by each piece of equipment. It also can detect and take or suggest corrective measures.

The performance of the energy systems within the school may be reported in the manner shown in *Figure 2-6*. Logically breaking down the energy systems into electrical loads and heating/ventilating/air conditioning groups allows the supervisor to evaluate the school's energy performance.

TOTALIZATION SUMMARY

TOTAL	L1 LIBR	L2 CHI	L3 STR	SAMPLED VALUE CLO	
				STATUS:	BEGIN
				BASE UNITS:	HRS
				TOTALIZE ON:	CLOSED

TOTALIZED VALUES			TOTALIZED LIMITS	
TODAY:	5.05 HRS			
CURRENT:	300.00 HRS		WARNING:	400.00 HRS
LAST MAX:	500.00 HRS	AT 12 MARCH 96 15:30	RESET:	500.00 HRS

Figure 2-5—Runtime totals are invaluable in planning preventive maintenance.

ENERGY MANAGER PERFORMANCE SUMMARY

FOR: MED MEDICAL WING POW POWER SYSTEM STATUS: BEGIN

FEATURE		ENERGY	SAVINGS DEMAND	COST
LOAD MANAGER				
DEMAND LIMITING		-----	-2500	-2750
DUTY CYCLE		-2200	-----	-950
	SUBTOTAL	-2200	-2500	-3700
HVAC MANAGER				
OPTIMAL RUN TIME		-875	-----	-370
SUPPLY AIR RESET		-220	-----	-85
ENTHALPY SWITCHOVER		-175	-----	-70
	SUBTOTAL	-1270	-----	-525
	GRAND TOTAL	-3470	-2500	-4225

Figure 2-6—Energy usage broken down into electrical loads and heating/ventilating/air conditioning groups.

DAILY PROFILE

DATE	PROFILE TIME	TOTAL ENERGY, KWH UNCNTRLED	TOTAL ENERGY, KWH MEASURED	PEAK DEMAND, KW UNCONTROLLED		PEAK DEMAND, KW MEASURED
05/05/96	ALL	35356	34321	3123 AT 12:10	L	2701 AT 13:12

PERIOD PROFILE

START DATE	PROFILE TIME	TOTAL ENERGY, KWH UNCNTRLED	TOTAL ENERGY, KWH MEASURED	PEAK DEMAND, KW UNCNTRLED		PEAK DEMAND, KW MEASURED	BILLED	RATCHET CLAUSE
05/01/96	ALL	3245121	2931621	3512	L	3223	0	100
04/01/96	ALL	2716237	2681218	3489	L	3002	3217	25
03/01/96	ALL	2612757	2409797	3346		2972	3145	10

Figure 2-7—Electrical load summary is helpful in avoiding new electrical demand peaks.

Further evaluation of electrical loads may be accomplished by the school computer as shown in *Figure 2-7*. By segmenting the energy systems into electrical loads, the school computer can be programmed to automatically turn off low priority loads to avoid a new electrical demand peak.

The HVAC summary in *Figure 2-8* documents the energy savings from one piece of heating/ventilating/air-conditioning equipment.

Manpower reports—The computer can be set up to schedule and report on the manpower used in maintaining equipment. Maintenance management computer programs allow the supervisor to evaluate schedules, tools, and costs associated with the maintenance of the physical plant.

The scheduling of maintenance may be reviewed by the responsible person through a maintenance schedule summary.

The maintenance scheduling summary in *Figure 2-9* documents the maintenance to be performed for the week along with the tools and skill levels required to perform the maintenance.

Associated costs also can be reported with the maintenance management package. See *Figure 2-10*. The maintenance cost summary performs the simple multiplication and addition of time spent and resources used so the costs for maintenance may be reviewed.

The computer is finding more and more applications in managing school maintenance, as well as in scheduling, monitoring, and reporting on equipment operations. The maintenance staff needs to be familiar with what computers do and how they do it.

```
FOR : LIBR - LIBRARY          FN1 - FAN SYSTEM
                                SAVINGS TODAY
     OPTIMAL START TIME        223.5 KWH  OPTIMAL STOP TIME      0.0 KWH
     SUPPLY AIR RESET         1430.0 BTU  ENTHALPY SWITCHOVER    0.0 BTU
                                PERIOD SAVINGS
     OPTIMAL START TIME       10280.0 KWH  OPTIMAL STOP TIME  2831.0 KWH
     SUPPLY AIR RESET            37.6 KBTU ENTHALPY SWITCHOVER   0.0 KBTU
     PERIOD START : 00 FEB  96
```

Figure 2-8—Performance summary reports the energy savings from various measures applied to one fan system.

		TASK	MATL	TOOL	TYPE	AVG. ACT. TIME
EUH SUMP PUMPS						
NOR NORTH BLDG	BASEMENT NORTH BLDG					
SUMP PUMP QUARTERLY PM		0001		0001	CAL	90
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
SUMP PUMP ANNUAL PM		0002		0001	CAL	240
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
SOU SOUTH BLDG	BASEMENT NORTH BLDG					
SUMP PUMP QUARTERLY PM		0001		0001	CAL	90
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
SUMP PUMP ANNUAL PM		0002		0001	CAL	240
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
RMT REMOTE BLDG	BASEMENT NORTH BLDG					
SUMP PUMP QUARTERLY PM		0001		0001	CAL	90
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
SUMP PUMP ANNUAL PM		0002		0001	CAL	240
						DISCONNECT CIRCUIT BREAKER
						STANDARD TOOLS AS REQUIRED
KIT KITCHEN						
FRE FREEZER	FREEZER # 1					
FOOD FREEZER RX-101 MONTHLY PM		0007	0201	0003	CAL	15

Figure 2-9—Summary of scheduled maintenance.

MAINTENANCE COST SUMMARY — MONTH TO DATE 10/25/95

BUILDING- ALL BUILDINGS — SYSTEM- ALL SYSTEMS

	LABOR HOURS	LABOR COST	MATERIAL COST	TOTAL COST
CHL PLANT SYSTEM				
PREVENTIVE MAINTENANCE.	8	55	20	75
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	8	55	20	75
SOU BUILDING				
PREVENTIVE MAINTENANCE.	0	0	0	0
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	0	0	0	0
1 NORTH BUILD.				
PREVENTIVE MAINTENANCE.	0	0	0	0
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	0	0	0	0
RMT BUILDING				
PREVENTIVE MAINTENANCE.	0	0	0	0
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	0	0	0	0
CUS CUSTOMER				
PREVENTIVE MAINTENANCE.	2	10	0	11
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	2	10	0	11
COMPLEX TOTAL				
PREVENTIVE MAINTENANCE.	10	65	21	86
PREVENTIVE BREAKDOWN. .	0	0	0	0
BREAKDOWN	0	0	0	0
TOTAL	10	65	21	86

Figure 2-10—Summary of maintenance costs.

3 / Controlling Energy Costs

Most school buildings built before 1970 were not designed with energy conservation in mind. However, energy consumption usually can be reduced by:

- modifying mechanical and electrical systems to make them more efficient;
- eliminating unnecessary energy usage, including wasteful practices and losses due to improper maintenance.

Controlling energy use begins with the tracking of expenditures to provide data for decision making and the education of building occupants to discourage wasteful practices.

Some steps to energy conservation involve significant capital investment and must be weighed against projected savings in order to determine their real value. However, it usually costs very little to eliminate unnecessary usage—such as by turning off lights in unoccupied rooms and keeping electric motors properly maintained. Any of these smaller steps taken individually save only small amounts of energy. Taken together, however, a great deal of energy consumption can be eliminated by altering behavior patterns, improving maintenance practices, and being constantly sensitive to energy costs.

Every school building should be subjected to a thorough energy audit conducted by a qualified professional. The audit should be designed to identify unnecessary energy losses and to evaluate the costs and benefits of corrective measures. The audit also should provide a cost-benefit analysis of modifications to mechanical and electrical systems, as well as to the building structure itself.

The biggest part of the school energy dollar goes for lighting, heating and cooling, so these are the first places to look for savings. It's also important to look at other electrical systems, domestic hot water, outside air intake, the building structure, and alternative energy sources.

Here are some suggestions for each of these areas, some of which involve significant capital investment and some of which are relatively low in cost.

HEATING, VENTILATING AND AIR CONDITIONING

Many of the following recommendations for reducing heat loss in cold weather will also apply to heat gain in hot weather. Room temperatures typically are reduced at night in cold weather to obtain energy savings. Ways of achieving additional savings by reducing ventilation and by additional modifications to the heating system are also worthwhile.

Each building represents a unique situation. Therefore, the suggestions below are general and must be tailored to the building involved.

Also note that legal standards governing school ventilation are altered from time to time in an effort to balance energy conservation with indoor air quality.

Low Cost Steps

1) Place thermostats on time clocks to reduce the building temperature when it is unoccupied.

2) Identify areas (such as storage rooms and garages) where heating and cooling are not criti-

Controlling Energy Costs, original chapter by Ronald W. Mixer, of Beling Consultants, Inc. Third Edition revisions by Glen L. Bellows, President of Buchanan, Bellows and Associates, Ltd., Bloomington, IL, and John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School.

cal and maintain reduced thermostat settings.

3) Use timers to close outside air dampers when spaces are unoccupied. Also, consider closing outside air dampers during the first and last hours of occupancy. *But be sure to check building codes for clean air standards.*

4) Allow natural humidity variations from 20 to 60 percent in occupied spaces.

5) Limit the use of all portable heaters, fans, and similar equipment.

6) Place exhaust fans on timers so they operate only when necessary to remove fumes or odors in accordance with clean air standards.

7) Use exhaust hoods only when the area served is in use.

8) Make full use of window coverings. During heating season, if the sun is not shining in all windows, they should be covered. Under some circumstances, windows may be used to light a room with light fixtures turned off.

9) Where heating involves multiple boilers, operate one at full-load rather than several at partial load.

10) Operate boilers at lower pressures or temperatures in accordance with the space heating demand.

11) Operate hot water circulating pumps and boilers in spring and winter only as needed.

12) Analyze flue gas periodically and adjust combustion of the boiler to maintain efficient combustion.

13) Inspect boilers to determine if they meet the operating conditions of the manufacturer. This includes inspections for scale deposits, deposits of fly ash or soot, and inspections of door gaskets and linkages. Check boiler stack temperatures and firing nozzles.

14) Inspect furnaces, make-up air units and unit heaters to be sure that heat exchanger surfaces are clean. Check for air leaks. Check exhaust gases. Check fans and motors and bring them up to the manufacturer's operating conditions.

15) Check for obstructions in front of radiators, convectors, and fin tube units. Purge all air periodically from high points of hydronic units. Clean the surfaces of all conductive heat transfer equipment.

16) Inspect all ductwork for leakage and repair. Check for loose insulation in ducts or around access doors. Inspect all dampers to make sure they are clean and well lubricated. Replace air filters periodically. Clean all coils and seal leaks around coils or casings.

17) Check to make sure that pumps and motors are aligned properly and motors are lubricated. Replace any worn bearings or seals.

18) Keep all fan blades clean. Lubricate all bearings or replace if necessary. Make sure all belts are of proper tension and in good condition. Make sure all discharge outlets are free of dirt and debris.

19) Clean strainers.

20) Inspect all pipe insulation in accordance with the building's asbestos management plan; repair or replace if necessary.

21) Inspect all piping for leaks. Inspect and repair or replace steam traps as necessary.

22) Reduce all ventilation and exhaust air to the minimum currently allowed by state law.

Significant Investments

1) Consider installing an automatic economy cycle on air-handling units that have cooling coils.

2) Install heat recovery devices for exhausted air.

3) Modify exhaust hoods to use primarily untempered outside air for make-up.

4) Consider installing new low-leakage dampers on all outside air openings.

5) Add new controls to close outside air openings when the building is unoccupied.

6) Adjust and balance the entire air distribution system to meet current design criteria.

7) Install boiler stack economizer.

8) Preheat heavy fuel oil with waste heat.

9) Reduce boiler blow-down losses.

10) Isolate off-line boilers.

11) Replace boilers that are at or near the end of their useful lives.

12) Replace a large boiler with several smaller boilers.

13) Isolate off-line chillers.

14) Consider shutting off or lowering the temperatures of the reheat coils on terminal reheat systems.

15) In dual duct systems, if either no heating or no cooling is called for, isolate the respective duct and operate as a single duct system with the heating or cooling coil modulating.

16) Consider using demand reset controls on multi-zone systems to reset the hot deck and cold deck temperatures from the area calling for the most heating or cooling.

ELECTRICAL SYSTEMS

The second largest consumer of energy is the electrical power used for illumination and for

operating various types of equipment.

When energy was relatively cheap, most schools adopted high illumination levels. With the increased cost of energy, it has become necessary to investigate alternate methods of illumination.

Energy consumption also can be reduced by modifying electrically-powered equipment.

While energy can be saved by removing fixtures and lamps, it must be realized that lighting is a system and should be evaluated fully before changes are made. Also, laws in most states establish illumination standards that must be met. For these reasons, professional assistance should be obtained in planning modifications to school lighting systems.

Low Cost Steps

1) Promote the use of lighting only when a room is occupied.

2) Replace old, inefficient lamps.

3) Clean lamps and fixtures on a regular schedule.

4) If windows are used for illumination, keep them clean.

5) Consider replacing lamps with lower wattage lamps providing the same or slightly less illumination.

6) Consider using appropriate lighting levels for different areas of the building. Corridors, for example, do not need as much light as a study area.

7) Consider a photocell on interior lighting next to windows to activate the lights.

8) Consider a photocell or time clock for outdoor lighting.

9) Consider reducing demand charges by relamping lights or rescheduling activities.

Significant Investments

1) Replace all frequently used incandescent lighting with fluorescent lighting or high intensity discharge lamps where feasible.

2) Consider adjusting the electrical system power factor if you are being billed for KVA demand.

3) Consider using time clocks to turn off noncritical equipment.

4) Consider installing a load programmer to shed loads in order to reduce demand charges.

See Chapter 23 for more suggestions on maintaining electrical systems.

DOMESTIC WATER

Domestic water heating is a significant portion of the total energy consumed in the schools. There are some rather inexpensive changes that can be made to a water system to reduce the energy consumed.

Low Cost Steps

1) Inspect the water system and repair all leaks, especially those at faucets.

2) Inspect insulation on storage tanks and piping, and repair as necessary in accordance with the building's asbestos management plan.

3) Consider using spring return water faucets.

4) If the water pressure exceeds 45 pounds, consider having the pressure reduced on both hot and cold water.

5) Reduce the hot water temperature. Usually 105 deg. F is adequate for lavatories and showers, while kitchens usually need 140 deg. F.

6) Install flow restrictors on all shower heads.

7) Consider controlling hot water circulating pumps thermostatically or with a time clock.

8) Disconnect all electric water coolers.

Significant Investment

1) Consider replacing electric water heaters with another energy source.

OUTSIDE AIR

Outside air, whether controlled or by infiltration, is expensive to heat and cool. "Infiltration" is defined as outside air that enters the building through cracks, windows, doors, and other openings in the building. All of this unwanted outside air should be eliminated or reduced to an acceptable minimum.

Low Cost Steps

1) Replace all broken or cracked window panes.

2) Replace all broken or cracked weather-stripping.

3) If cracks are evident around windows, either rehang windows to fit tightly or seal the cracks.

4) Encourage the occupants not to open windows during the heating or cooling season.

Significant Investments

1) Install tight fitting storm windows or thermal glaze.

2) Replace large glazed areas with thermal barrier installations.

3) Install vestibules at doors where traffic is heavy.

BUILDING STRUCTURE

Heat transmitted into or out of a building can be drastically reduced by modifications in the glazing and insulation. Those windows that should be treated first are those exposed directly to the sun or that are extremely large. Decisions to add insulation should involve technical assistance in order to avoid potential problems, such as condensation entrapment, and to ensure selection of the proper type and amount of insulation to be most cost-effective.

Low Cost Steps

1) During the heating season, close all interior shading devices to reduce night time heat losses.

Significant Investments

1) Consider adding a reflective film on all exterior windows subject to direct sunlight to reduce the cooling load.

2) Add draperies or window blinds.

3) Install exterior shading devices.

4) Consider adding new roof deck insulation, especially if the roofing is more than 20 years old.

5) Consider replacing unneeded windows with insulation panels.

6) Use opaque or translucent insulating materials to block off and thermally seal all unused windows.

7) Consider adding insulation to roofs, floors and walls around areas that are heated or cooled.

ALTERNATE ENERGY SOURCES

Both solar energy and wind energy have tremendous potential to reduce energy costs. The capital expenditure necessary to use this cheap energy is large. However, with escalating energy costs, the payback period for implementing one of these systems is growing shorter. Alternative energy sources that were not feasible two or three years ago may now offer an economical solution to energy problems.

Solar energy is used primarily for domestic water heating and, to a lesser extent, space heating. Solar domestic water heaters have been used throughout the world successfully where energy has been expensive. Implementing a solar heating system requires engineering assistance. There are many things to consider, including collector size, structural support of the collector, orientation, and storage capacity, before the implementation of such a system.

The use of solar energy for space heating is probably best done on new construction, because the cost of retrofitting may be prohibitive. This does not eliminate the possibility of cost effectiveness for certain areas of some buildings. A supplemental heating system usually will be necessary with every solar heating system.

Photovoltaics and wind energy are primarily used to generate electricity. Additional electricity will be necessary, of course, to provide continuous operation and can be purchased from the local utility company. In some cases, excess electricity generated can be sold to the local utility. Wind-generated electricity often is not of the same quality as purchased power. Adequate wind velocities are necessary for an economical payback on a wind generating system. Because of the high degree of engineering sophistication required, experienced and qualified assistance should be obtained before implementing such a system.

BUILDING AUTOMATION SYSTEMS

Building automation systems are another way of reducing energy consumption. These are expensive to install; however, the paybacks on these have been very good, often within three years. A building automation system can be used to monitor and control all building systems, fostering the most efficient use of energy and manpower. It can be programmed to cycle major equipment, shed loads where electrical billing is on a demand basis, and operate lights at various times of the day, among other functions. Building automation systems are generally used for large buildings. They vary from a relatively simple design that performs only a few functions to more sophisticated designs that provide security and fire monitoring as well as the monitoring of equipment and environmental conditions.

For more on automation, see Chapter 2, "Using Computers in School Maintenance."

4 / Safe Maintenance Practices

Safety has special priority in the public schools. School management must have as its first concern the physical safety of the boys and girls who are required to be there each day. For the maintenance team, this means giving continuous attention to all aspects of the building structure and equipment. It also means that each member of the team must acquire a mind-set—a deep sense of personal concern—that compels him to investigate any suspicious or unexplainable conditions.

In addition to the safety of those who work in and learn in the schools, the maintenance team itself faces, each day, some special circumstances that call for caution. Certain equipment and chemicals, for example, may create perils for the thoughtless or unwary user. It is essential, therefore, that each team member understand the potential perils, the limitations of his tools and the ways of going about his job without creating unnecessary hazards.

In its day-to-day work, the maintenance team is primarily concerned with the use of equipment and materials. What follows are some guidelines for the safety-conscious maintenance team.

1) **Aisles and passageways**—Keep aisles and passageways clear and in good repair with no obstruction across or in aisles that could create hazards. The Illinois Life Safety Code for Schools requires that primary egress corridors be free of storage, free of movable equipment that reduces passage to less than a minimum width or interferes with egress traffic flow, and free of refuse containers other than non-combustible units with covers.

2) **Compressed air**—In using compressed air for cleaning purposes, do not exceed 30 psi and then only with effective chip guarding and personal protective equipment.

3) **V-belt drives**—Guard the V-belt of all drill presses, including the usual front and rear pulleys, to protect the operator from contact or breakage.

4) **Emergency flushing**—Where the eyes or body of any person may be exposed to injurious corrosive materials, provide suitable facilities for quick drenching or flushing of the eyes and body within the work area for immediate emergency use. The Illinois Life Safety Code requires pull chain showers and eye flush devices in chemistry laboratories.

5) **Eye and face protection**—Protective eye and face equipment is required where there is a reasonable probability of injury that can be prevented by such equipment.

6) **Fan blades**—Guard the blades of a fan. The guard should have openings no longer than 1/2 inch. The use of concentric rings with space between them, not exceeding 1/2 inch, is acceptable provided they are adequately supported.

7) **Fire doors**—Do not block fire doors or tie them in an open position. Be sure building settlement is not causing doors to bind in either open or closed position. Fire doors located in corridors must be closed at all times except where magnetic hold-open devices are engaged and which release the doors to closed position in response to the fire alarm system. Fire doors separating hazardous locations, such as boiler rooms, must be kept closed at all times when the building is occupied.

8) **Fire protection**—Provide and maintain in an effective operating condition, portable fire ex-

Safe Maintenance Practices, original chapter supplied by the IASB Service Associates Maintenance Manual Committee. Third Edition update by Keith Middleton, of Middleton and Associates, Normal, IL, and John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School.

tinguishers suitable to the conditions and hazards involved. Conspicuously locate and mount extinguishers in accordance with state accessibility codes and do not obstruct or obscure them from view. Inspect and test portable extinguishers at least once a year; attach a durable tag securely to show next maintenance or recharge date. In storage areas, clearances between sprinkler system deflectors and top of storage varies with the type of storage. Check state codes for required clearances.

9) **Flammable liquids**—Can be highly hazardous to life and property. Check with local fire department officials for recommendations. Be sure that proper safety containers are available in the school shop finishing area. Bulk flammable liquids and paints should be stored away from the occupied building.

10) **Floors**—Keep all floor surfaces clean, dry and free from protruding nails, splinters, loose boards, holes or projections. Where wet cleaning is used, maintain drainage and caution signs; where practicable, provide false floors, platforms, mats or other dry standing places. In warm, highly humid climates, it may be necessary to maintain constant powered ventilation in a gymnasium with wood flooring to prevent expansion and buckling.

11) **Hand tools**—Keep tools and equipment clean and in safe condition.

12) **Housekeeping**—Keep clean, orderly, accessible and in a sanitary condition all places of employment, passageways, storerooms, and service rooms. Keep doors closed at all times while the building is occupied.

13) **Ladders, fixed**—Assure that all fixed ladders will support a minimum concentrated live load of 200 pounds applied at the center of the rung. The minimum diameter of rungs is:

- 3/4 inch if metal (in noncorrosive exposure);
- one inch if the ladder is constructed of metal rungs embedded in concrete and exposed to a corrosive atmosphere;
- 1 and 1/8 inch if the ladder is wooden.

Spaced no more than 12 inches apart, the rungs should have a minimum clear length of 16 inches. Vertical fixed ladders shall be spaced out from walls to maintain a minimum of seven inches measured from the rung to the wall. Head clearance back of the ladder should allow a minimum of two feet-six inches measured from the rung at right angle to the ladder side rails. Access ladders to elevated platforms shall be extended to a minimum distance of three feet-six inches above that platform (manhole and roof hatch ladders excepted). Paint or treat metal ladders to resist corrosion or rusting when the location demands.

14) **Ladders, portable**—Equip stepladders with a metal spreader or some locking device of sufficient size and strength to securely hold the front and back sections in open position. Maintain ladders in good condition and remove defective ladders from use. Erect non-self-supporting ladders on a sound base at a 1:4 slope and secure to prevent slipping. The top of a ladder used to gain access to a roof should extend at least three feet above the point of contact. Coat wooden ladders with a suitable protective material.

15) **Stationary electrical devices**—Provide non-current carrying ground at all stationary electrical powered equipment tools and devices placed within reach of a person who can make contact with any grounded surface or object. Install ground fault interrupter (GFI) outlets.

16) **Storage**—Stack, block, interlock and limit in height all storage, so that it is secure against sliding and collapse. Keep storage areas free from accumulation of materials that constitute hazards or pest harborage. Exercise vegetation control when necessary. Where mechanical handling equipment is used, allow safe-clearance for aisles, at loading docks and through doorways. Storage areas and storage procedures should consider the following guidelines:

- Storage areas should be kept orderly and free from accumulation of materials that constitute hazards, whether said hazards are a result of the nature of material stored or careless, disorderly placement of stored materials.
- Organize storage procedures so as to discourage the harboring of pests. Storage should be racked or spaced clear of the floor. Pest control against rodents and termites may become necessary where storage is long term. Consider the need for a pest management program for the building.
- Outside stock storage should be limited to a safe height, enclosed by safeguard fencing and should be spaced a minimum of eight inches free above the earth to discourage pests.
- Check inside storage areas for life safety compliance as to locations and required safety measures. Ensure that all storage in an occupied school building is provided with a heat detector to actuate the building alarm system.
- Inside storage should be preceded by a determination of floor load capacity and determination of a stored material weight.
- Where mechanical handling equipment is to

be used, allowances for safe-clearance must be made for aisles, at loading docks and through doorways. Determination of floor load capacities existing and those capacities necessary for storage operations should be considered beforehand.

• Storage should never occupy a non-floored area not suitably separated from occupied spaces.

17) **Trash**—Collect and remove trash and rubbish in such a manner as to avoid creating a menace to health and as often as necessary for the maintenance of good sanitary and visual conditions.

5 / Designing Buildings for Efficient Maintenance

The design of a building has a direct impact on building maintenance. A building can be designed to make maintenance relatively easy and low in cost. Such things as efficient traffic patterns, strategically located storage areas, and easy access to mechanical equipment can save thousands of dollars every year—over the entire life of the building—by eliminating needless building wear and inefficient maintenance work.

Building materials, too, can be selected for ease of maintenance—a characteristic which can quickly offset a substantially higher first cost. The following inventory is useful for remodeling existing buildings, as well as for building new ones. Generally, the extra one-time cost of installing low maintenance items is recovered in the first few years of operation.

The following list is incomplete, but it does offer ideas to be considered for employees and for occupants. Keep in mind that building codes and laws regulating access and safety may require—or restrict—use of various designs and materials.

GENERAL

1) Have safety requirements been considered?

2) Is there easy access to all mechanical equipment for maintenance personnel?

3) Is there a separate adequate main custodial storage area?

4) Are there adequate custodial closets on each floor and/or at strategic intervals?

5) Are the doors to all mechanical equipment rooms wide enough to get the equipment in and out?

6) Provide adequate clearances where filters must be removed for cleaning.

7) Is there adequate clearance in boiler areas for use of the cleaning equipment? Is access adequate to allow boiler service?

8) Allow adequate clearance in front of electrical panels.

9) Consider maintenance traffic; does it cross occupant areas? Can this be avoided or minimized?

10) Are there floor-type service sinks with adequate cleanout drains in custodial and other maintenance areas?

11) Where lockers are provided, use lockers with closed bases and slanted tops to minimize cleaning. In athletic locker rooms, consider extended, raised locker bases to provide seating in front of lockers.

12) Before occupying the building, see that complete operational and maintenance manuals are provided for all equipment. Maintenance personnel should be provided with operating instructions.

13) Have adequate floor drains been incorporated in areas subject to water from flushing, runoff, or periodic flooding?

14) Check ventilation in custodial areas.

15) Provide shelving, hooks, lighting, etc. for custodial storage areas.

16) Check lighting and electrical outlets for adequacy. Be certain that receptacle type and capacity match up with cleaning equipment.

Designing Buildings for Efficient Maintenance, original chapter supplied by Jack T. Harroun, University of Illinois (retired). Third Edition update by Keith Middleton, of Middleton and Associates, and John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School.

17) Review trash removal pattern from the building, including the locations of any elevators.

18) Provide a collection point for trash that is accessible for both delivery and removal.

BUILDING EXTERIOR

1) Ensure compliance with state and federal access laws by using ramps in place of steps at entrances.

2) In landscape planning, use low maintenance profile plant materials. Avoid handwork where possible. Lay out walks and plant materials to discourage people from walking on lawns. Landscape plantings should be spaced to accommodate passage of groundskeeping equipment with a minimum of follow-up handwork. Review traffic patterns, such as from parking lots to building entrances.

3) In geographic areas subject to snow and ice, avoid placing major traffic entrances on shady north side of the buildings. Ice and snow removal can be aided by exposure to solar radiation.

4) Provide security type water faucets on building exteriors every 100 feet or so for window washing, watering plants, etc.

5) Consider emergency access for fire fighting equipment and locate drives, parking, plant materials, and walks accordingly.

6) Is drainage adequate for walks, entrances, lawns, and parking areas? Assure that downspouts do not direct roof water onto sidewalk surfaces which may become a danger when icy.

7) Avoid unprotected subgrade entrance areas.

8) Assure that building subgrade areas within the building are protected from water migration at the exterior wall.

BUILDING INTERIOR

1) Use medium colored floor coverings and choose materials which are readily cleaned and show minimal soil.

2) Use dark baseboards and choose materials that resist scuff marks and resist damage.

3) Where floors are exposed to heavy loads, select floor coverings that can withstand the wear.

4) Avoid interior steps or similar obstacles to the movement of equipment or to the use of cleaning equipment. Assure that steps and ramps are appropriately appointed and marked to meet state and federal regulations for pedestrian and handicapped traffic.

5) Assure that all interior subgrade areas are adequately protected from water infiltration and adequately drained. Non-assignable areas should be adequately drained.

6) Assure that provisions are adequate and proper for compliance with state health codes for preparation and storage of food.

7) Assure that an emergency flushing and shower facility is provided in the chemistry laboratory.

8) Assure that the facility addresses the Americans with Disabilities Act in every respect.

RESTROOMS

1) In planning washrooms, check traffic flow and locate fixtures accordingly. Mirrors and shelves located away from lavatories will aid traffic flow. Provide for handicapped accessibility in accordance with state and federal requirements.

2) Check washroom accessibility in relation to occupant patterns.

3) Assure that toilet facilities and access space are adequate in terms of occupant use with particular attention given the handicapped.

4) Are floor drains adequate?

5) Is there storage for toilet room supplies available within a reasonable distance?

6) Is ventilation adequate?

7) Use nonporous floors, walls, and ceilings which are easily cleaned and do not contribute to fungus growth or conditions creating odors.

8) Use wall-hung urinals, commodes, partitions, wash basins, and sinks. Enclose pipes wherever possible under wash basins. Consider open throated urinals.

9) Select partitions which are sturdy and fabricated to accommodate cleaning procedures.

10) Provide adequate dispensers for soap, towels, toilet paper. Double toilet paper holders and extra towel cabinets are recommended to reduce time for servicing.

11) Fixtures and mirrors should be screened so they are not visible from entryways.

12) Provide an adequate number of electrical outlets (ground fault type only).

13) Because toilet floors are water mopped frequently, make them as free and clear as possible and provide with adequate drainage.

WINDOWS

1) Reduce energy waste (air conditioning and heating losses) by reducing the number of windows and/or using thermal sash and thermal glazing.

2) Reduce dust catching surfaces.

3) Review window cleaning requirements in choosing window types.

WALLS

1) Review wall cleaning procedures and choose wall coverings that resist soil and film.

2) Use wall-hung water fountains and use protective wall coverings.

3) Use dark baseboards.

4) Assure that drinking fountains meet handicapped accessibility standards.

5) Confirm that the location of fire alarm signals and extinguishers are in accord with code requirements.

ELECTRICAL SERVICE

1) Assure that electrical service is adequate and in compliance with ground fault regulations.

2) Assure all electrical panels are accessible and have proper clearance. A minimum unobstructed clearance of four feet is typically required.

3) Review electrical and lighting systems for energy conservation.

4) Assure that emergency lighting systems are adequate.

5) Review building use and provide an adequate number of outlets to reduce the use of extension cords.

6) Assure that all electric motors are easily accessible for periodic maintenance.

7) Consider the use of key switches in public areas.

8) Assure that lighting is adequate and easy to clean. Is replacement of lamps convenient?

9) Assure that exit lights are properly located.

10) Assure that exterior lighting is adequate and on automatic control.

11) Review provisions for telephones.

12) Assure that power service outlets and/or receptacles meet intended usage requirements.

FLOORS

1) Assure that floor coverings do not contain materials designated as hazardous to human health by the Environmental Protection Agency.

2) Stock extra tile of each pattern and color for replacements.

3) All hard floors, such as concrete or terrazzo, should be sealed.

4) Use medium colored floor coverings for ease of daily maintenance.

5) Consider use of mats at entrances and in elevators to collect and hold soil. Floor recesses for mats or special shoe cleaning pads are not recommended.

6) Do not use resilient tile floor coverings in areas that are water mopped daily.

7) Assure that floor finish in food handling areas are proper for compliance with the state health codes and readily cleanable and maintainable.

8) Assure that adequate provisions are made for ventilating and drying off of locker rooms adjacent to gang showers.

SPECIAL CONSIDERATIONS

1) Assure that the food service arrangement is efficient and the traffic pattern is adequate.

2) Assure that food service equipment is appropriate, adequate and that installations are in compliance with the state health and sanitation standards and recommendations.

3) Assure that sanitary waste lines are provided with adequate and strategically located cleanouts.

4) Assure that reasonable flexibility in mechanical and electrical installations is considered in school shops and other specialized areas.

6 / Environmental Issues—A Primer for Maintenance Staff

Members of the maintenance/custodial staff cannot avoid confrontation with environmental issues. In fact, they often bear major responsibility for compliance with regulatory standards, and they typically encounter situations every day that call for at least a general familiarity with environmental hazards and how to handle them.

This manual is designed to provide physical plant administrators and staff with a general guide to the most frequently encountered areas of environmental compliance and management for schools. Topics covered here include:

- Environmental site assessments
- Liability insurance for environmental work
- Asbestos
- Bloodborne pathogens
- Electromagnetic fields
- Indoor air quality
- Lead in paint
- Lead in water
- Radon
- Underground storage tanks
- Waste management
- Worker right-to-know laws

Because environmental regulations are in a constant state of change at the federal, state and local levels, this manual does not offer a definitive list of rules and regulations. Rather, the material in this chapter attempts to alert the staff to potential hazards and to provide a starting point for finding answers. For its part, the maintenance/custodial staff must be in regular contact with the regulatory agencies and other sources of information.

Included in the Management Tools Appendix is a list of government agencies and other organizations that can provide up-to-date information.

Keep in mind that federal regulations represent minimum standards and states may require more stringent practices and procedures. Be sure to check with your local, state and federal regulators and your professional environmental consultant before establishing compliance procedures or commencing any environmental project.

ENVIRONMENTAL SITE ASSESSMENTS

It is advisable to have an up-to-date Environmental Site Assessment on all real estate owned or used by the school district. The written results of such an assessment—sometimes called an audit—provide guidance for the maintenance staff.

Site assessments are usually required by the buyer (or by law) whenever real estate changes hands. In fact, *a school district should never acquire property—by purchase or as a gift—until a preliminary audit has been completed.* This applies to transfers of real estate from developers who may be required to provide acreage or buildings for schools. Depending partly on its past use, a building or parcel of land can bring with it liability for all manner of environmental hazards, including disposal of toxic substances. *Dealing with environmental hazards can cost far more than a piece of property is worth,* because toxic cleanup is extremely expensive, involves countless hours of paper work, and may obligate the

Environmental Issues—A Primer for Maintenance Staff, a new chapter by William C. Bradley, of C & W Bradley, P.C., Rockford, IL.

school district in perpetuity.

Presumably, the property owner responsible for creating a particular waste product is forever responsible for that waste. However, proving that someone else created a waste product or toxic hazard can be extremely difficult—and costly in legal fees—unless a site evaluation was conducted at the time of property transfer.

Environmental Site Assessments are a very cheap insurance policy that help protect both the property seller and the buyer.

Such assessments can and should be conducted in steps or phases. A Phase One Assessment determines whether further steps are necessary. Phases Two and Three respond to needs, if any, uncovered in Phase One.

A Phase One Assessment normally includes:

1) A site reconnaissance (walk-over) of the property to observe any areas of environmental impact including, but not limited to, stored hazardous waste, underground or above-ground storage tanks, potential asbestos sources, potential lead-based paint sources, and distressed vegetation indicating possible soil contamination.

2) An investigation through local, state and federal agencies to determine whether the property has been issued any special permits of an environmental nature or has been cited for environmental violations.

3) A title search to determine whether past usage of the property might have any environmental impact or if there are any environmental liens on the property.

4) Complete documentation, including a written report, copies of documents, photographs and any conclusions or recommendations for further action.

A Phase Two Assessment normally includes:

1) Specific sampling for any suspected contamination noted in Phase One, including, soil analysis, asbestos sampling and lead-based paint sampling.

2) Complete documentation, including sampling methodology used, laboratory reports and explanations of findings.

A Phase Three Assessment normally includes an action plan for cleaning up the site of contaminates based on the data collected from the previous assessments. This is usually the most expensive part of the work.

Because Phase Two sampling, soil borings and reporting are usually the least expensive part of the work, it is preferable to spend the extra dollars to sample on a site than to remove extra materials that are considered contaminated and in actuality are not. Many of the materials removed in a Phase Three cleanup will end up in a landfill, but they remain the lawful property of the building/land owner forever. This makes the school district the designated entity to help clean up the landfill in the future, because the U.S. Environmental Protection Agency will look for those involved entities that have the financial ability to pay for the clean up.

Some additional tips:

1) Never, if you can help it, have your name on a waste manifest.

2) Determine the precise extent of any contamination. This will avoid the cost of removing materials that are not contaminated.

3) If you become involved in a cleanup of contamination on your site or a landfill, be prepared for a very long dispute. And be sure to use recycled paper because you will definitely kill many trees with the paperwork involved.

INSURANCE

Liability insurance is a major cost consideration in any environmental work. Although such coverage is available to cover almost any type of environmental procedure, building owners should not assume that a contractor or consultant is covered, because that is *not* always the case. Not all states require environmental contractors to provide evidence of insurance prior to licensing. The school official must either require evidence of proper insurance coverage or take steps to have the school district acquire (and pay for) the necessary protection.

Although environmental liability insurance will cover work to be performed by the contractor, it is important to make sure that this coverage applies specifically to the project under consideration (i.e., asbestos, underground tanks, lead paint, radon). Get it in writing.

Also, check the policy and check the insurance company's rating. Ask your school district's insurance provider to explain the contractor's policy to you.

Consultants can also get errors and omissions insurance for environmental projects covering design, project observation, air sampling, inspections, and similar functions. The policies are easy

to get if the consultant has a good track record but they are also very expensive.

Note that the consultant can reduce insurance costs that are passed on to the district by obtaining long-term blanket coverage (usually one year) rather than a separate policy for each project. However, a district should not have to pay for more than it's prorated share of the consultant's annual premium. Insurance costs should be stated up front or incorporated as overhead in the consultant's fees. They should not be written into the bid specifications for the contractor to pay and pass on to the district.

ASBESTOS

Asbestos materials in schools are regulated under the federal Asbestos Hazard Emergency Response Act (AHERA), which requires school districts and not-for-profit schools with students in grades K-12 to inspect and identify asbestos in their facilities, manage the materials according to a written Management Plan, and perform repair and abatement activities according to strict guidelines.

One or more state agencies are responsible for administering AHERA regulations. Check with your state education department to determine the responsible agency in your state. (In Illinois, AHERA regulations are administered through the Illinois Department of Public Health.) The responsible agency monitors all aspects of asbestos management in school districts and handles the accreditation of training programs and licensing for asbestos professionals.

State agency regulations may be stricter in many respects than those established under AHERA. Most of the following regulations are required by all states.

Staffing

In Illinois, the Department of Public Health licenses the following Asbestos Professionals:

Asbestos Inspector — conducts necessary inspections of school facilities.

Management Planner — prepares assessments of asbestos materials and response actions for those materials.

Project Designer — prepares designs, plans and specifications for major asbestos abatement projects.

Project Manager — acts as the school district's representative on asbestos abatement projects and monitors the activities of contractors and subcontractors.

Worker/Supervisor — individual who can work on major asbestos abatement projects in addition to routine operations and maintenance procedures. Note that most states require any asbestos work be done by certified/licensed workers.

Air Sampling Professional — individual who, independent of the contractor, does air testing in and around the asbestos project. This professional must have completed a special course, offered by the National Institute of Occupational Safety and Health, covering the counting of asbestos fibers in the air.

The Designated Person

Each school district or school must appoint an individual as the "designated person" for asbestos. This person should undergo a minimum of one-day (eight hour) training and receive written evidence to that effect. (In Illinois, licensing through IDPH is not required.) In general, a Designated Person is responsible for ensuring that:

1) Maintenance staff are properly trained for handling asbestos materials (this is discussed later).

2) Any person making repairs involving asbestos materials is properly certified and licensed and that this is properly documented in the district's Management Plan.

3) All outside vendors are properly notified of the existence of asbestos containing materials in a facility and this notification is kept in the Management Plan.

4) There is a yearly notification to parents of students in a facility regarding any past or planned asbestos related activities and reminding them of the availability of the facility's Management Plan.

5) All asbestos-containing materials in all facilities are inspected at least every six months, with the information used to determine any action needed regarding these materials.

6) Warning labels are affixed and maintained on all friable asbestos materials in service and maintenance areas.

7) Ongoing operations and maintenance procedures for all asbestos related materials are

monitored.

8) Re-inspections are conducted for all district facilities by certified and IDPH (in Illinois) licensed inspectors and management planners at three-year intervals.

9) All information regarding asbestos in a facility is kept in the facility's Management Plan.

The Management Plan is a key element in all of these activities and is perhaps the most important document a school district has regarding asbestos in their facilities.

The Management Plan

The Management Plan is a written plan developed for a school district for the management of asbestos in its school buildings. This is a "living document," meaning it is constantly updated with any and all information regarding a facility's asbestos materials. The Management Plan must be kept in the facility office and the district office even after a facility is deemed asbestos free. It must be available to the general public upon request. The Management Plan should be used to provide outside vendors with the locations of asbestos materials and should contain a sign-off sheet for an outside vendor to confirm awareness of this material. Also, the parents of district students must be given yearly notice of the availability of the Management Plan, even after a facility is deemed asbestos free. A copy of the notice must be kept in the management plan.

The Management Plan contains the following:

1) All information from the original asbestos inspection of the building, including findings, material locations, assessment of condition, response actions and the credentials of the original inspectors and management planners.

2) Copies of the six-month periodic surveillance of asbestos containing materials.

3) Records of any maintenance, removal or repair of any asbestos materials in the facility.

4) Operations and maintenance procedures for the asbestos materials in the building (usually developed with the assistance of a Management Planner).

5) Copies of the triennial re-inspections (required under AHERA and conducted by a licensed Inspector).

6) Copies of project logs for any abatement activities (submitted by the Project Manager).

It is essential to remember that the school district is responsible for the proper documentation of any asbestos activities.

Facilities Affected by AHERA

All public school districts and non-for-profit school facilities, for any grade—kindergarten through 12th— owned or leased by a district, or a portion of a facility used by a district for student activities (such as storefronts, church schools and houses) fall under AHERA regulations. This includes temporary instructional facilities, such as trailers and temporary classrooms.

School districts should require for any new additions, remodeling or new building that contract specifications clearly state that no asbestos containing materials will be used in any building products. This should be spelled out prior to any bidding of work or hiring of consultants or contractors, including vendors such as plumbers, electricians, boiler service companies, pipe insulators, boiler insulators, telephone personnel, floor tile installers, terrazzo installers, roofers, waterproofing contractors and others.

Facilities built after 1988 can be certified asbestos free by a licensed architect or professional engineer and do not fall under AHERA regulations. This information must be kept on file with the district and your state asbestos regulatory agency.

Staff Training and Certification

There are three levels of training for school maintenance individuals who come into direct contact with asbestos containing materials:

1) A two-hour training for all maintenance staff regarding asbestos in general and site specific training for staff working in a particular facility.

2) An additional 14 hours of training for any maintenance staff whose activities would or could disturb asbestos containing materials.

3) Additional training (up to 40 hours) for certification of such personnel as workers, inspectors, management planners or supervisors. These individuals must have yearly physical examinations, if exposed to asbestos, and be properly licensed (in Illinois and most other states) to conduct small scale operations and maintenance activities.

Abatement Guidelines

The school district can use trained and licensed personnel to conduct small repair or removal activities involving up to three square feet or three linear feet of asbestos-containing materials only in emergency situations. Check your state requirements for small repair and removal projects. These personnel cannot be used in lieu of a major abatement project.

However, if the district uses its own personnel for large abatement projects, these guidelines must be followed:

1) Only licensed workers can be used. Check your own state for these requirements.

2) Air sampling following OSHA guidelines must be done for workers to prove they are using proper respiratory protection. This is a federal OSHA requirement.

3) Yearly asbestos medical examinations must be conducted for workers and maintained by the district for at least 30 years after termination of the worker's employment. This is a federal OSHA requirement.

4) The district must have a written respiratory protection program in place. This is a federal OSHA requirement.

5) Only equipment designed specifically for asbestos work can be used.

6) The district must comply with worker Right-To-Know rules as they relate to asbestos projects (see page 31).

7) Note that in many instances the school district must also be a state licensed asbestos contractor with proper insurance to do abatement work.

In Illinois, the school district must provide written notification to IDPH and Illinois Environmental Protection Agency (IEPA) 10 working days prior to the commencement of any abatement activities. Check with your individual state for the requirements of notification. Note that improper notification is one of the most frequently cited infringements of the asbestos rules. *The minimum 10-working-day notification is required by all states.* The school district can be fined heavily for violation of this policy and these fines multiply for the number of days the district is in non-compliance. Fines can be up to *$10,000 per day per violation.*

When in any doubt about asbestos in your district, ask your architect or consultant or call the United States Environmental Protection Agency (USEPA) or state agency for guidance.

BLOODBORNE PATHOGENS

Exposure Control Plans

Bloodborne pathogens include HIV/AIDS, hepatitis B, and various other diseases that can be transmitted through contact with infected blood, blood products and/or other bodily fluids. If anyone in the employment of a school district or other work site could be exposed to blood, blood products or other potentially infectious materials, federal OSHA standards require that the employer develop a written exposure control plan. The plan may cover school nurses, laundry workers, athletic trainers, first aid providers, etc. Custodial staff also should be included in this category because they may be called upon to clean up blood or other bodily fluids.

OSHA makes available to the public publications on bloodborne pathogens and related programs. Also, most states have approved programs for school districts to use. Call your state health department, OSHA or your state regulatory authority to see what is available as a guide for your own program.

Remember that waste generated from blood contact is regulated and must be disposed of properly. Contact your local hospital or other health care provider for a list of medical waste disposal companies. Also, inquire as to the regulations for blood waste disposal in your state.

Typical Procedures

All school employees need to be taught one overriding principle: *if it came from someone else's body, do not touch it without proper training and safety equipment.*

A local plan for controlling exposure needs to include a section for cleaning spills and disposal that might read as follows:

Transport Packaging—Carefully package all contaminated materials already in red disposal bags or boxes in leak proof shipping boxes provided by the waste hauler. Be sure to wear all required protective equipment. Sharp items shall be packaged in thick PVC or vinyl containers so as not to puncture outer surfaces and allow leaking.

When a receptacle is full, the large red bag shall be securely tied and over-packaged with another bag. The receptacle shall then be relined

with another red bag with the proper identification as a biomedical and potentially infectious waste. Containers shall be decontaminated on a regular basis.

One employee from housekeeping shall be designated to collect all bags from the central collection point on a scheduled basis and at least once per day. Using a dedicated cart (only for this kind of waste and no other) to collect all bags and boxes the employee shall:

• Wear proper protective clothing at all times (usually gloves and a gown or Tyvek suit);

Securely tie red bag in the receptacle and place bag in the cart. Disinfect and reline the collection container. Transport the collected red bags to the facilities central packaging and treatment area.

Packaging of waste—Waste to be treated on site shall be packaged in leak proof boxes provided by the waste treatment/disposal company.

• Line the box with a red bag of at least 3 mil thickness.

• Pack collected bags in the waste disposal/treatment company's box. Do not over pack or crush bags in the box, but try to make sure no large spaces are in the box.

• Securely flap box and tape. Note the condition of the box and check for leaks. Repack or over pack as necessary to stop leakage. Follow spill clean up requirements for decontamination of spill/leak area.

Waste pick up—Here the disposal company will provide you with its requirements for pick up and proper protective procedures for its workers.

Procedures for Spills

Small Spills—A small spill is one which can easily be handled by one person, and will usually involve less than a quart or liter of liquid. For a spill, the following equipment shall be available:

• gloves — to be disposed of
• surgical mask —to be disposed of
• goggles
• cover gown — to be disposed of
• red bags — to be disposed of
• sponges — disposable
• germicide which is TB effective phenol or "quat" or 1:10 bleach to water
• paper towels — to be disposed of
• mops — to be disposed of
• plastic dust pans — can be decontaminated

Decontaminate equipment by soaking in disinfectant solution for eight hours. When a spill occurs, clean-up procedures will be instituted at once. The employee shall wear gloves and—depending on the amount of anticipated splashing—goggles, mask and a gown shall be worn as necessary.

Procedures: Don protective clothing. If any articles of the affected person's possessions are involved, place them into the red bag for disposal if it is practical or decontaminate the items with a germicide solution for 15 minutes.

Using paper towels, remove all extraneous materials. Place used towels in the red bag. Sharp objects such as glass shards, pins, needles and knives shall not be picked up by the hand directly.

Cover affected area with germicide solution and let stand 15 minutes. Wipe area dry. Discard all personal protective equipment.

Place red bags from the clean-up in the designated collection area.

Large spills—Procedures are essentially the same as for a small spill, but goggles, gown and surgical mask are required. Personal protective equipment shall be provided at no cost to the employee. All cleanup materials that cannot be adequately disinfected shall be disposed of.

Also, the area is to be cleaned three times with disinfectant, letting it stand each time for 15 minutes.

Because of confidentiality rules and non-discrimination in the workplace and privacy rules regarding employees' medical records, the involved individual's medical condition and other health related information is not to be disclosed or discussed with anyone before, during or after any spill. Treat all spills equally.

ELECTROMAGNETIC FIELDS

Electromagnetic Fields are extremely low frequency fields, usually 60 cycles per second, generated by any electromotive force (voltage), such as generators, motors, microwave ovens, 120 volt power lines, underground and overhead power transmission lines.

So far, researchers have not agreed on whether these fields pose a hazard to human health or not. One of the links investigated was whether electromagnetic fields might produce hormonal changes in the body that might cause cancer, such as leukemia.

If you want to check for such fields in your building, a Gauss Meter is available from scien-

tific instrument catalogs and electrical supply catalogs for about $50 to $100.

More information can be obtained by contacting the sources listed in the Management Tools Appendix under "Environmental Resources."

INDOOR AIR QUALITY

"Sick building syndrome" is the name often applied when building occupants are afflicted with illnesses that are associated with the building itself. Ailments are often respiratory in nature, but can include flu-like symptoms. The victims usually feel better or exhibit no symptoms when they're not in the building.

Issues regarding sick buildings usually fall under the broad heading of Indoor Air Quality (IAQ). Although air quality problems stem from a variety of causes, 50 to 70 percent of all IAQ problems are due to inadequate fresh air—a situation often linked to energy conservation measures used in the 1970's and 1980's. Old standards specified five cubic feet per minute (CFM) of fresh air for each person in a building. Newer standards require 20 CFM for offices and 15 CFM for reception areas, classrooms and libraries. These standards need to be addressed when doing any building construction or renovation, especially as regards the HVAC specifications.

Other areas of poor IAQ include:

1) Glues, mastic and other building materials can give off—or "outgas"—volatile organic compounds, including glues that are formaldehyde or toluene based. Even "water based" glues can outgas. One way to avoid this problem is to make sure that furniture, carpets, glues, mastic, paints and other similar items are certified by the manufacturer or supplier to have low outgassing potential. Many manufacturers carry specific lines of equipment and materials that are "environmentally friendly."

2) Bacteria, fungus and molds can grow in the heating/cooling (HVAC) system. Have your system inspected; especially check the ducts and filters and condensate pans for the cooling systems. Clean or replace any that are extremely dirty or showing signs of growing mold. (A famous case of Legionnaire's Disease was found to be caused by bacteria growing in a cooling tower next to the fresh air intake of the afflicted hotel.)

3) Check the fresh air intake. Check to see if there is standing water nearby that would support the growth of molds and spores. Make sure dampers work properly. Be especially aware of where intakes are located. Keep them away from exhausts by locker rooms, restrooms, shop areas, automotive tech areas, art rooms, painting rooms and vehicle parking areas. (One example of a poorly placed intake involved a hospital with a fresh air intake located next to where ambulances idled at the Emergency Room entrance. The intake was pulling in exhaust fumes from up to five ambulances usually parked there, and building occupants were understandably complaining of gas smells.)

4) Be sure to clean up all wet areas and leaks as soon as possible to stop bacteria, molds and mildews from forming. Replace building materials that are supporting such growth.

To avoid IAQ problems in new construction or remodeling, make sure the district's architect, engineer or consultant is following American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) recommendations from their Standard 62-1989. This is referenced in the BOCA National Mechanical Code M1604.2 for fresh air ventilation and should be adhered to for the district's HVAC systems.

A good way to investigate existing problems is to keep records of the symptoms associated with IAQ (itchy eyes, dry throat, irritated skin, nausea, etc.), and the date and time they occur. Maintain these records for at least a week (preferably a month) and see if the symptoms coincide with installation of such things as: laser printers, copiers, carpets, desks, new interior paint, new copier fluids, pest control activities, use of cleaning agents or renovation of the HVAC system.

Inspect the Material Data Safety Sheets (MSDS) for all products used in the building to see if they might have any harmful properties and keep them on file for future reference. A good point to remember is just because a product is "water based" does not mean it is environmentally friendly. Muriatic acid (hydrochloric acid) is mostly water!

LEAD IN PAINT

Ingested lead affects the body by taking the place of calcium uptake. Calcium helps nerve growth in children and proper nervous system function in adults. Because lead in the body acts differently than calcium, learning disabilities and lead poisoning can result. Lead poisoning can also affect development of the brain, red blood

cells and bone marrow.

In the 1950's and 1960's, the primary concern with lead was preventing children from ingesting lead paint chips. The focus today is on stopping the ingestion of lead dust from deteriorated paint and the abrasion of painted surfaces. Poisoning from dust particles is more common today than from paint chips. Thus, lead regulations have now generally shifted to reduce invisible lead dust hazards and prevent the disabilities, both mental and physical, caused by ingestion. Proper cleaning techniques and lead paint abatement can help reduce exposure to lead.

Federal Housing and Urban Development (HUD) guidelines are leading the development of lead regulation in residences in the same way that school rules for asbestos became the standard for asbestos abatement in buildings other than schools. Many states have written laws regarding lead inspections, abatement and licensing. In Illinois all lead abatement done in buildings that will have children under the age of 7 using the facility in any manner must use workers that are certified and licensed for lead abatement. This includes, but is not limited to, residential housing, pre-school (Headstart programs), day care in homes, private and public schools — in short, any school that has a kindergarten with students under the age of 7 years.

If the abatement work will be done by contractors rather than by staff, then a contractor's license is also required by law in Illinois. Check with your local, state and federal agencies regarding regulations in your area. In some instances the health department is required to do investigations of buildings where children have been occupying the area when they have had high blood lead levels. This investigation could require you to have some kind of lead abatement done in your building.

Also, many states require that children (depending on their age) be tested for blood lead levels prior to entering school. Check with your state or local health department regarding requirements.

USEPA Lead Regulations

All waste containing lead paint must be tested by TCLP (toxic contaminant leaching procedure) for lead content. Waste with a 5 parts per million (ppm) or higher content of leachable lead must be disposed of as hazardous waste. (The TCLP mimics waste in a landfill by agitating a sample—usually in an acetic acid solution—to see how much the sample will leach lead out over a period of time if disposed in a landfill.)

All waste should be separated into several waste streams: liquid, materials (rags, suits, filters, etc.), paint chips, and architectural components with paint still attached. (Architectural components may qualify for a TCLP testing *exemption*.)

All waste (except liquid) should be wrapped in 6 mil polyethylene plastic and be labeled as lead waste. All non-hazardous waste must be taken to an EPA approved landfill.

Waste originators (building owners) with hazardous waste above the minimal quantities must obtain a GIN (generator's identification number) from the EPA, usually both from the federal and state agencies who regulate this material. Ask your state agency about this when you call them.

Lead Paint Abatement

The federal Occupational Safety and Health Administration (OSHA) requires that all workers wear some type of double foot covering and, in some situations, a double "Tyvek" suit while inside an abatement area. Upon leaving the abatement area, the outer covering is removed to avoid tracking lead dust out of the work place.

Depending on the lead level and project design, many jobs will need a decontamination unit (showers, clean room, dirty equipment room, etc.). Workers will need, at a minimum, to have a clean room where they can wash and change clothes.

Not all jobs have Negative Pressure Enclosures because, unlike asbestos, lead dust particles fall out of the air quickly (in less than one hour).

In addition to worker safety requirements, lead abatement involves lead blood testing. If workers are exposed at the action level of 30 micrograms of lead per cubic meter of air for 30 days, they will have to take a blood test (ZZP test) every 30 days for the first six months. If no elevated blood lead level is found (50 micrograms of lead per deciliter of blood or above), the workers can take a blood test every six months for the first year. Any worker who reaches a level of 50 micrograms of lead per deciliter of blood or above must be removed from the abatement activities and placed in a job of no lead exposure at the same rate of pay. If no such job exists, the worker will stay at home and be paid the regular salary (not worker's compensation). The worker shall stay in this category until two blood tests (at least 7 days

apart) show that the blood lead level is below 50 micrograms of lead per deciliter of blood.

Note that the above requirements are a federal OSHA requirement. States that administer their own OSHA standards modeled after the federal standards may have at least the same or more stringent standards.

Clearances for EPA, HUD, Illinois Department of Public Health

Because lead dust does not readily stay airborne, clearance on lead abatement jobs is demonstrated by using wipe samples on abatement area surfaces. These wipe samples should cover 144 square inches (or one square foot) and not be taken in a circular or scrubbing motion. Use an "S" type of motion. First, wipe north to south then east to west so the lead dust collection is standardized.

Samples are to be taken on horizontal surfaces that face up when dust will fall out of the air and onto the surface (do not take ceiling samples). A combination of several testing surfaces may be composited into a single multi-wipe sample. This can save on laboratory costs, but if that wipe fails all areas from that sample fail and recleaning of all the areas will be necessary.

State of Illinois rules on clearance of an area are the more stringent at this time compared to HUD rules, but the EPA may become the most restrictive in the setting of clearance standards in their future rules.

LEAD IN WATER

Lead in water can pose a serious and immediate health hazard to children. Some schools are required to test for lead in water and meet specified requirements; some are not. Check with your state and local health departments regarding testing of your water. Some states may require it.

All consumable water (both for drinking and cooking, hot and cold) from all taps should be tested, including cold water from bubblers.

A level of .015 milligrams (or 15 parts per billion) lead in water constitutes an action level. An environmental consultant can provide the district comprehensive testing services, help determine the source of contamination, and provide recommendations on how to remedy the situation.

Other issues involving lead in water include:

1) Solder for plumbing. School districts are now required to use 90-5-5 solder (90% tin) which contains a lower lead count than the previously used 50-50 solder (50% lead). All plumbing contractors and building maintenance staff should be aware of these requirements.

2) Faucets and spigots may off-lead. Test both hot and cold water after a new fixture is installed to make sure it is not causing any contamination. EXAMINE ALL SOLDER REELS SUPPLIED TO YOU FOR LEAD CONTENT.

3) Some water chillers and water coolers (bubblers) contain high amounts of lead. These should not be used because of the potential for contaminating water. The USEPA has a list of these potential problem units.

4) Municipalities are also required to test for lead in water. Check with local officials regarding these results. The district's water supply may be a source of contamination.

RADON

Radon is a colorless, odorless gas formed from the natural decay of uranium in the soil. Radon can be found almost everywhere because there are varying amounts of uranium in soil throughout the world.

The gas makes its way into a building through dirt floors, cracks in concrete floors and walls, floor drains, sumps, joints and tiny cracks or pores in hollow block walls. By itself radon gas is not harmful to breathe. Health problems are caused by decay products from the gas which form into very small solids and attach to dust particles in the air. When inhaled these particles can get caught by the natural mucus in the lung tissue. Over a period of four to five days, the radon particles decay five more times releasing an alpha particle each time. The alpha particles can injure any nearby cell structure and possibly cause a cancer cell to grow in the lungs. A piece of paper could stop an alpha particle but the body's lung cell walls would not. Skin with many layers of dead cells would stop an alpha particle but a cell in the lungs would not.

The effects of radon are dose related, meaning the more a person is exposed at a higher level the greater chance they have of contracting lung cancer from the effects of the gas.

Currently there are few federal or state regulations covering radon, but it is certainly advisable to check the radon levels in all the district

classrooms, offices and other habitable areas. Note that it does not matter how new or old your building is when it comes to the amount of radon in a building. Also, changes in use or remodeling of a building and changes in the heating, cooling, and exhaust system can change radon levels dramatically. It is advisable to test after these changes are made. Also, you can do soil flux tests on building sites to test for the relative amounts of radon in existing soil.

There are several ways to test for radon gas:

1) Charcoal canisters, a method of short-term testing taken over two to five days. The results from these tests are not as reliable as other methods but can point out areas for further testing.

2) Alpha testing, a longer term testing taken over three months to one year. Alpha testing provides more reliable results (the longer the test period the more reliable the results) and is often done as a follow-up to charcoal canister testing.

3) Electronic testing, where radon levels are checked as often as every 15 minutes. This method is normally used to determine where and how radon gas is getting into a building.

The recommended level for radon gas is less than four picocuries (pc/l). Levels of four to 20 pc/l mean further long term testing and perhaps the installation of a mitigation system is needed. Levels of more than 20 pc/l over a one-year period mean immediate action should be taken to provide mitigation.

Radon sub-slab mitigation systems are relatively simple to install. Most of them are de-pressurization systems that suck the air out from under a building's slab to prevent it from reaching the building. That air is exhausted outside of the building away from air intakes or children's play areas.

The USEPA does certify radon mitigation contractors on a voluntary basis. However, a contractor does not have to be certified to install a system. The Illinois Department of Nuclear Safety (IDNS) requires that radon testers and mitigators be trained and registered with the department to offer such services in Illinois. Check with your individual state on these requirements.

School officials can call their state radon regulatory authority or the USEPA for a list of testers and contractors or if they have questions regarding radon. Most states have a radon hotline to call.

Laws regarding radon are still being written on the state and federal level. It is best to check with your local, state or federal authorities prior to hiring anyone to do testing or installing of a mitigation system.

UNDERGROUND STORAGE TANKS

Federal regulations require individuals, companies or public institutions (including school districts) to register underground storage tanks (USTs) with the state fire marshal or your state or federal regulatory agency. If a UST was installed without certain protective devices—such as leak detectors, cathodic protection (corrosion protection on steel tanks) and other devices—the UST has to be upgraded or removed and replaced with a UST incorporating these devices. Either alternative can be very expensive.

Prior to removing a tank, the school district must fill out an application from the fire marshal, who will establish a date for the removal and will be on site to observe the removal and determine whether the tank has leaked any product (gasoline, oil, etc.) into the surrounding soil. If there has been no leakage, the tank can be properly cleaned and recycled. If a leak has occurred, the district must follow regulations regarding clean up of the site.

In Illinois, regulations regarding leaking USTs are administered through the IEPA and the State Fire Marshall (OSFM). Some costs associated with a leaking UST can be reimbursed from the State of Illinois with a deductible of $10,000 to $100,000, depending on whether the tank was registered properly. In Illinois the amount of deductible is determined by the OSFM.

In other states, check with your state environmental agencies for the people who cover underground tanks.

IEPA classifies leaking UST's in three categories based on the potential impact on the environment. These categories are: No Further Action, Low Priority and High Priority. IEPA makes the determination based on geological study of the site referred to as a "Site Classification". This study would be conducted by a consultant to the school district.

If the district has a leaking UST, it can request a site specific clean-up based on special conditions. This would allow the district to use higher limits of soil test results for certification as a clean site. The district's consultant or IEPA can help in this area.

Clean up from a leaking UST and reimbursement activities can take up to two years to complete and involve a large amount of paperwork and follow-up with IEPA. For that reason most districts choose to work through a qualified consultant to help this process along.

Starting in 1995, IEPA requires training for all UST removal and testing contractors and consultants and is planning to test and license these individuals. Districts should make sure their consultant is properly trained for UST work.

An alternative method many UST owners are using to clean-up contaminated soil is bioremediation. This employs the use of naturally found bacteria that consume pollutants in the soil. This is usually less expensive than hauling and disposing of contaminated soil and helps the UST owner avoid future liabilities associated with contaminated soil in a landfill. A qualified environmental or engineering consultant can advise a district on the feasibility of bioremediation and the requirements from IEPA to use this method.

WASTE MANAGEMENT

All waste generated by the school district belongs to the school district forever. This includes asbestos waste, hazardous waste, paper waste, food waste and contaminated soil from a leaking UST. This means that if the landfill used by the school district is ever targeted for a clean-up, the district along with other "deep pocket" users of the landfill will be charged for that clean-up.

The district may avoid this expense only by proving that the only waste generated for that landfill was non-toxic, but considering the amount and varying types of waste generated by a school district, that is unlikely.

The proper handling of hazardous materials (including fertilizers, pesticides, chemical treatments, waste from bus barns and auto shops, etc.) is regulated by content and/or quantity of material by local, state and federal law. These regulations may entail special handling, storage and disposal requirements including a Hazardous Materials Communication Program placed on district facilities by the county's Emergency Services and Disaster Agency (ESDA). A list of MSDS sheets and quantities for hazardous waste materials should be submitted to ESDA for evaluation.

There are three relatively simple methods to avoid future problems associated with a district's waste management:

1) Recycle. A district should have a waste minimization program in place to lower the amount of waste brought to a landfill and lower exposure to future liability. Since most monetary judgments on landfill users are based on what is placed in the landfill and in what quantity, decreasing the amount of waste could reduce monetary penalties. The USEPA has publications on recycling and many local communities have started their own programs.

2) Use one landfill. It is advisable to use one hauler and one landfill on an ongoing basis for waste disposal. If the district uses a different hauler and landfill based on low bid every year, the district will multiply its potential liabilities. When bidding out a hauling contract, therefore, it is a good idea to specify that the waste hauler use one landfill that's selected by the school district.

3) Keep records of waste amounts. Often a district's dumpsters are emptied on a regular basis regardless of how much is in them. In some clean-up determinations, USEPA will calculate a district's liabilities based on the maximum amount a dumpster would hold. Ask your hauler to document the actual amount taken from a dumpster or modify your contract so dumpsters are emptied only when they're full.

4) Check with your attorney, superintendent, purchasing manager, and business manager regarding bidding requirements on any environmental project.

The USEPA has pamphlets regarding waste minimization and hazardous waste management. You can call your regional USEPA office to obtain these documents or get information from your state waste authority.

WORKER RIGHT-TO-KNOW

OSHA regulations are specific regarding the rights of workers to be aware of materials they deal with on a job site. In Illinois, the public sector is regulated by the state Department of Labor.

There are seven basic employer responsibilities:

1) Posting of a right-to-know sign (a summary of employee rights).

2) Acquisition, maintenance and employee access to Material Safety Data Sheets for each hazardous chemical in the workplace. These sheets must be kept for 10 years after the use of the product is discontinued. Suppliers are sup-

posed to provide these free of charge.

3) Submittal of a list of acquired MSDS sheets to the Illinois Department of Labor. Check with your state labor regulator for your particular requirements.

4) Proper labeling of all hazardous materials. Exempt materials or areas include:

- Products intended for the personal consumption of employees.
- Hazardous and special waste.
- Consumer goods when packaged and used by employees with no greater exposure than expected from consumer use.
- "Warehouse" materials transferred in sealed packages (however, emergency procedures must be taught).
- Prescription drugs.
- Laboratories.
- Most retail outlets which do not normally sell toxic substances.
- Articles—material with a specific design and function which does not result in exposure to a toxic substance under normal conditions of use.

5) Initial and annual training of all employees exposed to hazardous materials.

6) Contact with the local fire department concerning the toxic substances present at the workplace.

7) Development of a written Hazardous Materials Communication program that contains a description of how the criteria stated above will be met along with other related documentation.

Worker Right-to-Know requirements are in addition to other written safety programs where an employee is exposed to hazardous substances (i.e., respiratory protection program if respirators are used, yearly medical monitoring, chest x-rays for asbestos workers).

Employees have the right to refuse to work with a specific substance if not supplied a MSDS sheet for it and cannot be discharged or disciplined for exercising their rights under Right-To-Know. Workers can petition their state or federal OSHA compliance agency to add materials to the Toxic Substance List and have their physician receive a copy of any MSDS sheet whether or not the material is listed on the Toxic Substance List.

The district/school should have a designated person assigned to oversee the provisions of Right-To-Know regulations (not necessarily the same person who handles asbestos issues) and should follow all protocols set up by the county emergency service disaster agency office.

Right-To-Know regulations can be complicated and their application to specific materials confusing at best. A consultant can assist the district in designing a program based on specific needs. Most insurance companies will have a loss control specialist or a certified safety engineer who can help a district comply with these regulations.

Also, environmental contractors are required to have most of these programs in effect. To create a starting point for a local program, a school district can include safety programs in its written bid specifications.

In Illinois, a school district can request the state Department of Labor to conduct a compliance inspection without penalty for violations noted at that time. By doing so, however, the district agrees to correct any violation before a re-inspection and can be fined for continued violations. Check with your own state agency, school district attorney and insurance company regarding compliance inspections.

Pamphlets explaining worker Right-to-Know rules are available from regional OSHA offices. (See "Environmental Resources" in the Management Tools Appendix.)

Section TWO

Cleaning and General Building Services

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7 / Organizing the Custodial Operation

The regular custodial care of school buildings affects the educational process in many ways. For one thing, it affects the safety and well-being of all users, including students and teachers. For another thing, it affects the life of the building and its contents and the rate at which they deteriorate.

Custodial care, moreover, has a decided impact on the school's appearance—its image and the attitudes of people who work there, study there, visit, or just drive by.

Most important, custodial care affects the educational climate of a school and determines, in large part, whether it is an effective place for teaching and learning.

In order for the maintenance team to meet its important responsibilities within reasonable costs, the manager must ensure that the entire custodial operation is properly organized. For the manager this means:

- Starting with clear goals and policies;
- Organizing work;
- Organizing people;
- Organizing other resources;
- Evaluating the results.

Each of these five managerial steps includes a number of essential considerations.

GETTING STARTED

Policy

A written policy statement that clearly states the aims of the board of education and that is acceptable to the administration and most employees is a vital basis for a well-managed maintenance program. See the examples in *Figure 7-1*.

The board should consult with custodial workers and managers to write a policy that takes into account, as far as possible, the practical problems and concerns of those who will organize and perform the work.

Some goals that should be included in any policy are:

- Schools that are well-maintained and attractive;
- Costs that are reasonable and justified;
- A fair work load for each employee;
- A standard of professionalism that expects all employees to use initiative and take pride in their work.

The policy should provide a mission for the maintenance/custodial program and create conditions that will encourage supervisors and staff to strive for high performance standards. This in turn will provide those using the buildings with the basic conditions they need to excel in teaching and learning.

The school administration must recognize, understand and support the "work management concept" under which workers are trained to take responsibility for the best use of time, equipment, and supplies to accomplish established standards of work performance.

Division of Responsibility

Those who use facilities share responsibility for their upkeep. A written policy outlining this responsibility is helpful. Following are some guidelines:

- Those using classrooms and other facilities

Organizing the Custodial Operation, original chapter by Jack T. Harroun, University of Illinois (retired). Third Edition review and update by John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School.

CUSTODIAL SERVICES

The schools of the district shall be maintained in a sanitary and attractive condition. To this end, an adequate staff of custodians and sufficient supplies and equipment shall be provided.

The custodial staff shall receive direction and supervision in the performance of its tasks. There will be an active inservice training program to increase effectiveness and to introduce new products and methods.

Maintaining a clean and orderly school building is not solely the responsibility of the custodian. All staff members need to be thoughtful and cooperative, not only in their own actions but also in developing standards and habits on the part of the pupils.

BUILDINGS AND GROUNDS MAINTENANCE

The buildings of the school district represent a substantial investment by the community. They shall be maintained in good condition by a continuous program of repair, replacement, and preventive maintenance.

Major work which requires specialized skill or equipment may be performed by contractors, usually during vacations to avoid interference with classes. The superintendent shall submit to the board a descriptive listing of such projects, together with cost estimates and an indication of priority. The board will determine which projects shall be undertaken and will authorize bidding as required.

The services of an architect or other specialist on a consultant basis may be utilized when deemed necessary in making an informed judgment, or to prepare plans and specifications as needed.

Attractively landscaped school grounds add value to the community.

Figure 7-1—Examples of school board policies

should consider those who will use the room after them.

- Rules and regulations governing students should include rules concerning the upkeep and appearance of school property, with penalties for violation.
- In some schools, students police areas before they are dismissed, gathering trash and so forth.
- Responsibility for cleaning in special areas, such as laboratories or shop areas, may be shared with the department.
- Window sills cluttered with plants and other items should not be dusted by the custodian.
- Where floor areas are cluttered, only traffic lanes should be cleaned.
- Exterior doors are locked and unlocked according to the supervisor's instructions.
- Interior doors are locked and unlocked in accordance with school district policies.
- School policy should be established regarding lost and found items, use of bulletin boards, use of telephones and other school property, and other matters as needed.
- Requests for special custodial services should be made to the supervisor, who will evaluate the need and determine whether the request should be granted.
- Unrelated services, such as running errands, should not be requested of custodians.

Professionalism

Creating a spirit of professionalism among custodial staff is the surest way to insure a high level of work and dependability.

A good training program is the first step in encouraging custodial workers to take a professional attitude, and this should be reinforced by the attitude of managers and other school personnel toward the custodial staff. Staff should be treated as professionals by all school personnel. In addition, custodial workers are entitled to a well-managed and carefully organized program that ensures a fair workload for all workers and that provides the time and equipment necessary to do a good job.

Professionalism includes:

- Job knowledge, which begins with a training program and continues with judgment and skills gained on the job. Careful supervision is important to ensure the latter.
- Dependability, which includes punctuality, careful reporting, and conscientious carrying out of work.
- Attitude toward work and organization. Good working conditions and proper equipment to do a good job are essential to creating a good work attitude.

All custodial workers should be provided with a clearly-written statement of professional standards, preferably as part of a locally-developed custodial handbook.

Training

Supervisory training—Working supervisors may be crew leaders (an employee who is basically part of the work crew and devotes approximately ten percent of his or her time to supervision) or a foreman whose primary job is supervision.

In either case, special training for supervisors

is essential for a well-managed work program. In many cases, supervisors are custodial workers who were promoted to supervisory levels because they were outstanding workers. However, special skills are needed for supervisors.

Normally, a supervisor is knowledgeable about the technical aspects of the work but needs training, for example, in giving instructions to other workers. Training should include:

- Fundamentals of supervision and the role of the custodial supervisor.
- Communications skills.
- Motivation of workers.
- Scheduling and planning work.
- Making decisions and solving problems.
- Recruitment, selection and orientation of custodians.
- Training and evaluation of custodians.
- Interviewing and counseling of custodians.
- Handling worker complaints and grievances.
- Discipline.

Initial training—All new employees must be trained to perform work to an understood standard. This training should be based on a manual or written program describing the supplies, equipment, tasks, procedures/methods and programs to be followed. The final section of this chapter provides suggestions for producing a local custodial manual. Also feel free to use any of the appropriate material contained in *Good School Maintenance*.

Training may be done by immediate supervisors, fellow employees, an outside consultant, or a combination.

Continuing training—Continuing training is essential both for workers and supervisors. This consists of periodic refresher training and special training on new topics that arise from time to time, such as use of paid sick time, communications, sexual harassment, and so forth. In addition, selected custodians and supervisors should be sent at least once a year to conferences or workshops for training and ideas.

Special training—Whenever a new piece of equipment, a new product or new policy is introduced, special training should be provided by supervisor, vendor, consultant, or member of the administrative staff.

Sources of training—Training programs and materials are available from a variety of sources, including:

- nearby universities may offer programs on sanitation management and may have available video tapes and other materials they can lend to school districts.
- many manufacturers who want their products used properly offer various types of instruction. Many vendors also have access to the many audiovisual programs produced by the International Sanitary Supply Association.
- associations of custodial and grounds maintenance supervisors. Other good sources include the Association of School Business Officials and its state chapters and the International Sanitary Supply Association.

ORGANIZING WORK

General Maintenance Tasks

General building maintenance tasks can be organized into daily, periodic, and special task groupings. This list is not all inclusive and other tasks may be added:

1) Daily tasks

a) Floors
- Wet clean toilet floors
- Vacuum carpets and treat spots
- Dust mop most hard and resilient floors

b) General dusting
c) Waste removal
d) Clean inside glass and mirrors
e) Clean fixtures (water fountains, toilet)
f) Clean chalkboards
g) Spot and emergency cleaning
h) Close windows and turn off lights
i) Lock and unlock doors
j) Report repairs needed

2) Periodic tasks

a) Floor sealing
b) Floor refinishing
c) Floor buffing
d) Carpet shampooing
e) Carpet pile lifting
f) Window washing
g) Screen cleaning
h) Venetian blind cleaning
i) Drapery cleaning
j) Wall washing
k) Furniture waxing
l) Upholstery vacuuming
m) Swimming pool cleaning
n) Snow removal

3) Special or seasonal tasks

a) Lawn care
b) Tree care
c) Shrub care

d) Heating and ventilation responsibilities
e) Painting
f) Training
g) Limited furniture moving and repair
h) Limited setups
i) Sanitary napkin vending operation
j) Limited custodial supply delivery
k) Limited supply and equipment testing

Task Responsibilities

Organize task responsibilities in writing so that workers know what they are responsible for and how their tasks interrelate. In a school, the general building maintenance responsibilities might be listed as follows:

1) Routine sweeping and/or mopping of floors; the dusting of trim, furniture, tops of desks and tables (when free of material and/or apparatus), bookcase glass, window ventilators, telephones, desk lamps; the emptying of independent, floor-type waste containers, ashtrays, and disposal of debris.

2) Periodic cleaning, buffing, and finishing of floors and the cleaning of windows and blinds.

3) Cleaning of blackboards (unless otherwise requested), chalk trays, and the replacement of chalk and erasers as necessary.

4) Closing and locking all windows.

5) Cleaning of drinking fountains and all plumbing fixtures.

6) Furnishing of materials and supplies required for the above and the supply of toilet paper, towels and liquid hand soap where dispensers are installed.

7) Collection and removal of trash.

8) Cleaning of mirrors and interior glass.

Routine Task Procedures

It is essential that persons performing any given task understand in detail all of the procedures that are involved. He must know, for example, such things as:

- What the task is intended to accomplish.
- How the task is to be performed.
- Standard of cleanliness required.
- Frequency of the task.
- Equipment and supplies needed and how they are used.
- Any safety or other considerations.

The procedures suggested for most routine tasks commonly called for in any public school are set forth in Chapter 9.

Cleaning Principles

Some cleaning principles useful in guiding members of the building maintenance staff are as follows:

1) Cleaning personnel and their work are important.

2) Productive cleaning is scheduled when the area to be cleaned is vacant or during a period of low occupancy.

3) A standard of cleanliness must be appropriate to the area being served.

4) Occupants' habits have a direct affect on the standard of cleanliness and the cost of achieving it.

5) Inadequate cleaning facilities increase cleaning costs by increasing unproductive time.

6) Modern management concepts must be used.

7) Avoid using custodial personnel for personal tasks or errands, since this results in unproductive time, excessive costs, and dirty buildings.

Standard of Cleanliness

To organize and achieve the desired standard of cleanliness, the following items must be considered:

1) The standard of cleanliness must be appropriate to the area serviced.

2) The standard of cleanliness must avoid over cleaning, as well as under cleaning.

3) It should be understood that cleaning for appearance is expensive but important for many areas of the school.

4) The standard of cleanliness is based primarily on:
   - Level of appearance desired
   - Legal requirements
   - Safety issues, including bloodborne pathogens

5) Desired standards are achieved through:
   - Cleaning services performed
   - Frequency of those services
   - Work skills of custodial staff
   - Habits of occupants

Organization of Time

The best time to schedule maintenance is during periods when the area is vacant or has low occupancy. For example, clean and refinish the floors during school vacation periods.

Unscheduled or emergency work should be done based on need and urgency. Each need must be studied and a decision made for best results.

WORK SHEET—DETERMINING FREQUENCIES FOR CLEANING AND SERVICES

Use the legend below to indicate how often each task must be performed in each area of the school.

AREAS / TASKS																			
Cafeteria	AN			5W	5W	5W	AN	1W	A	5N	A3	AN	5W	1M	1W	1W	AN	AN	SA	AN
Classrooms			6W		5N	5N	AN	1W	A		A5	AN	5W	A	VP	SA	3W	AN	SA	AN
Corridors	AN				5N	5N	AN	1W	A	5N	A3	AN	5W	A	1M	3M	5W	AN	SA	AN
Entrances					5N	5N	AN	5W	SA	5N	A3	AN	5W	A	1W	1M	5W	AN	1W	AN
Gymnasiums			5W	5W	5W	5N	AN	1W	A	5W	A5	AN	5W	A	AN				SA	AN
Laboratories		AN	5W	5N	5N	5W	AN	1W	SA	5N	A5	AN	5W	A	VP	3M			SA	AN
Library, Music Room			5W		5W	5W	AN	1W	A		A3	AN	5W	A	VP	SA	3W	AN	SA	AN
Locker/Shower Rooms	AN				5N	5N	AN	1W	A	5W	A3	5W	5W	A	1M	1M			SA	AN
Offices			5W		5W	5W	AN	1W	A		A5	AN	5W	A	SA	A	2W	AN	SA	AN
Restrooms				5N	5N	5W	AN	1W	A	5W	A3	5W	5W		1M	1M			SA	AN
Shops			5W		5N	5N	AN	1W	SA	5N	A5	5N	5W	A	VP	A			SA	AN
Stairways					5W	5N	AN	1W	A		A3	AN			1M	A			SA	AN
Swimming Pool	AN			5N	5W	5W	AN	1W	A	5N	A5	5W	5N		AN	A			SA	AN

5W—Five times a week
4W—Four times a week
3W—Three times a week
2W—Twice a week
1W—Once a week

3M—Three times a month
2M—Twice a month
Q—Quarterly
SA—Semi-Annually
A—Annually

A3—Every three years
A5—Every five years
AN—As needed
AU—After every use
VP—During vacation periods

Figure 7-2—Custodial managers can use these suggested frequencies as a guide until local experience shows more clearly how often various tasks need to be performed in each area of the school. A work sheet similar to this table is available in the Management Tools Appendix.

Establishing Frequencies

How often should a floor be swept? Scrubbed? How often should light fixtures be cleaned? Frequencies must be determined by the custodial manager based upon such factors as the standard of cleanliness desired, occupant usage of the area, and the availability of custodial staff.

A helpful way to begin planning is to produce a table of task frequencies such as the example in *Figure 7-2*. A full-size blank table is provided in the Management Tools Appendix. The manager can use the frequencies suggested in *Figure 7-2* as a starting point and modify them based on experience. Listing the frequencies in a single table will make it easier for the manager to grasp the total workload that must be allocated to the custodial staff.

Time Standards

There are many uncontrollable variables in custodial services caused by such items as the building (design, use, age, state of repair), custodial facilities, undefined responsibilities, purchasing regulations, personnel aspects, union agreements, benefits, untrained supervision, occupant demands, building size, and geographic location. However, the following organization of time appears to be a reasonable starting place

with the understanding that locally developed standards are the best. Well-managed programs in large buildings should do better than this guide.

1) Based on once-a-day frequency and a five-day school week, an institutional standard of cleaning is possible using 125 to 200 annual man hours per 1,000 square feet (gross) of floor space.

2) The tasks listed on page 36 under "General Maintenance Tasks" include custodial services and their suggested frequency and represent the general cleaning needs for school buildings. While it must be understood that the list is not all inclusive, with proper local management it should be adequate for most school buildings.

3) A dollar value is reached by multiplying 125 to 200 times the average hourly custodial pay rate for the particular institution, times the number of units of 1,000 gross square feet of floor space. The dollar value represents all normal custodial costs.

Here is an example of a Task Time Breakdown, based on 150 man hours per 1,000 gross square feet:

Services	Time %	Annual man hours per 1,000 sq. ft.
Floors (daily)	20	30
Floors (periodic)	20	30
Dusting	8	12
Waste removal	10	15
Glass cleaning	7	10.5
Fixture cleaning	12	18
Entrance cleaning	2	3
Furniture waxing	1	1.5
Locking/unlocking	2	3
Closing/raising windows, etc.	1	1.5
Repairs reporting	3	4.5
Spot cleaning	1	1.5
Wall washing	1	1.5
Miscellaneous	12	18
	100%	150

ORGANIZING PEOPLE

Personnel Coordination

To properly organize people, the manager must coordinate work crews with area cleaning assignments (or stations). There usually are several possible combinations of crews/areas/assignments, one of which is bound to be most efficient.

Fair work loads, as well as productivity, depend on proper organization. Since work loads vary, it might be best to organize work arrangements along these lines:

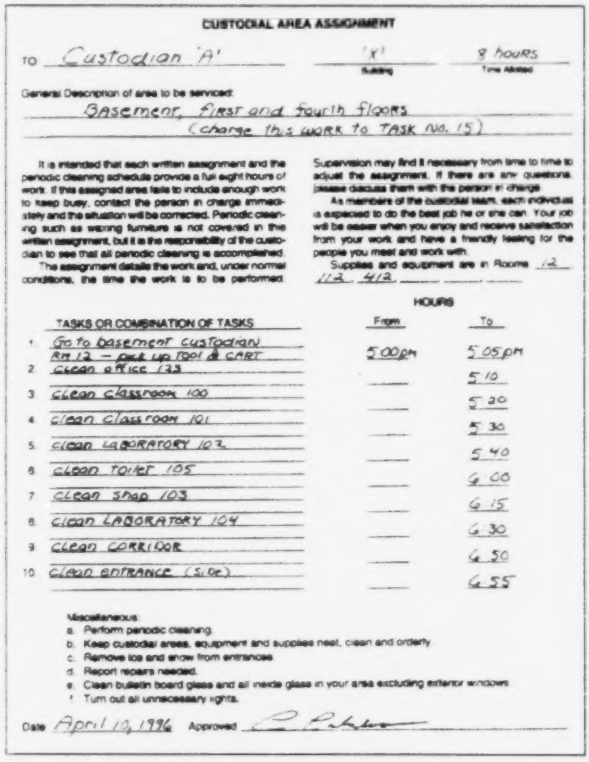
1) Use large areas where one person performs most, if not all, of the services. (This represents an area or station cleaning assignment.)

2) Use back-up crews to fill in area or station vacancies first and to perform periodic work (such as window washing or floor maintenance) when they are not needed for areas or stations.

Custodial Assignment

Each custodial assignment should provide the worker with a written plan outlining work sequence, time schedule and approximate time needed for each specific job. Assignments should be based on an established schedule that allows buildings to be cleaned with minimum inconvenience to users. See *Figure 7-3*.

Custodians should be encouraged to use common sense and understanding in completing jobs. They must be flexible enough to deviate from the written assignment as needed to handle emergencies. However, if certain deviations from the assigned work sequence reoccur, the assignment



CUSTODIAL AREA ASSIGNMENT

TO: Custodian 'A' — 'A' (Building) — 8 hours (Time Allotted)

General Description of area to be serviced:
Basement, First and Fourth Floors
(Charge this WORK TO TASK No. 15)

It is intended that each written assignment and the periodic cleaning schedule provide a full eight hours of work. If this assigned area fails to include enough work to keep busy, contact the person in charge immediately and the situation will be corrected. Periodic cleaning such as waxing furniture is not covered in the written assignment, but it is the responsibility of the custodian to see that all periodic cleaning is accomplished.
The assignment details the work and, under normal conditions, the time the work is to be performed.

Supervision may find it necessary from time to time to adjust the assignment. If there are any questions, please discuss them with the person in charge.
As members of the custodial team, each individual is expected to do the best job he or she can. Your job will be easier when you enjoy and receive satisfaction from your work, and have a friendly feeling for the people you meet and work with.
Supplies and equipment are in Rooms 12, 112, 412

	TASKS OR COMBINATION OF TASKS	HOURS From	HOURS To
1	Go to Basement Custodian Rm 12 — pick up tool & CART	5:00 PM	5:05 PM
2	Clean office 123		5:10
3	Clean Classroom 100		5:20
4	Clean Classroom 101		5:30
5	Clean LABORATORY 103		5:40
6	Clean TOILET 105		6:00
7	Clean Shop 103		6:15
8	Clean LABORATORY 104		6:30
9	Clean CORRIDOR		6:50
10	Clean ENTRANCE (SIDE)		6:55

Miscellaneous:
a. Perform periodic cleaning.
b. Keep custodial areas, equipment and supplies neat, clean and orderly.
c. Remove ice and snow from entrances.
d. Report repairs needed.
e. Clean bulletin board glass and all inside glass in your area excluding exterior windows.
f. Turn out all unnecessary lights.

Date: April 10, 1996 Approved:

Figure 7-3—Here is a sample form that provides the custodian with a clear understanding of the work that must be accomplished. A full-size version of the form is available in the Management Tools Appendix.

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should be reviewed and changed.

Periodic cleaning—such as wall washing or furniture waxing—normally is not included in the written schedule, but is done when time is created via work-management techniques taught during training.

Any problems arising with assignments should be discussed with a supervisor.

A sample Custodial Area Assignment form is provided in the Management Tools Appendix. *Figure 7-3* shows how the same form might look when filled out.

ORGANIZING OTHER RESOURCES

Budget Organization

The financial plan or guide is the major control over other considerations in maintenance, so that budget flexibility should be encouraged along with responsible management. Rigid budgets stymie leadership, stop needed improvement, and tend to stagnate the operation. Expect all members of the maintenance team to produce and operate an economical program.

Custodial studies indicate, in general, that the cleaning dollar is divided as follows:

- 90 to 95 percent for labor
- 5 to 10 percent for material and equipment

Contracting

All custodial operations supervisors should have the flexibility to use either in-house or contract personnel to perform maintenance work.

Specialized work often can be done more quickly or at lower cost by a contractor who does such work regularly and has the necessary equipment and skilled employees. Examples include electrical work, plumbing, exterior high-rise window washing, and tile work.

Contracts should be awarded on a competitive basis.

All work that can be done in-house at costs competitive with those charged by contractors should be done by in-house staff.

Equipment and Supplies

The right equipment in the proper amount at the right place at the right time (and in good condition) is necessary for productive cleaning. Assign specific responsibility for equipment and supplies. Remember, unused equipment represents a poor investment and reflects unfavorably on everyone. Also, professional custodians know how to use all types of equipment productively. This is part of their skill and work knowledge.

The basic supplies and equipment and how they are used in school cleaning are presented in Chapter 10.

A form that custodians can use to order needed supplies is provided in the Management Tools Appendix.

EVALUATING RESULTS

Work Inspections

Work inspections may be formal or informal, but the philosophy is the same for all inspections, and that is "to help everyone do a better job." In general, this means the supervisor should compliment good work, and not disregard but seek improvement in poor work.

A personal visit to the work area remains one of the best controls. Such a visit is most helpful when it results in written information on work, equipment, supplies, etc. Among other things, these reports provide a basis for future inspections, because they point out weak and strong points.

CUSTODIAL INSPECTION REPORT

WINDOW MAINTENANCE

MAY 15, 1996

I. Crew Inspected: "T" "D"

II. Building: MAIN Loc. No. 6 Areas Insp: 3rd & 4th Floors

A. Window Washing (Condition of Windows: Heavy soil ☐ Avg. soil ☒ Light soil ☐)

1. Procedure Used		2. Equipment		3. Supplies	
Belts	☒	Buckets	☒	Cleaner used:	
Window pole	☒	Sponges	☒	AMMONIA	☒
	☐	Chamoisskin	☐		☐
	☐	Squeegee	☒		☐
	☐		☐		☐

4. Condition of Supplies and Equipment

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Equipment	☒	☐	☐	☐	☐
Supplies	☒	☐	☐	☐	☐
Belts	☒	☐	☐	☐	☐
Ladders	☒	☐	☐	☐	☐

B. Dusting (Condition of Venetian Blind: Heavy soil ☐ Avg. soil ☒ Light soil ☐)

1. Procedure Used		2. Equipment		3. Supplies	
Vacuuming	☒	Back vac	☐		☐
Washing	☐	Vacuum	☒		☐
	☐	Duster	☐		☐

4. Condition of Supplies and Equipment

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Vacuum	☐	☐	☐	☒	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

III. Work Evaluation (1—Unsatisfactory, 2—Marginal, (3) Average, 4—Above Average, 5—Outstanding)

1. Quality of Finished Work 1 - 2 - (3) - 4 - 5 (Circle one)

Streaky windows	☐ Yes	☒ No	
Blind dusting	☒ Adequate	☐ Inadequate	
	☐ Accidents	☐ No Accidents	

2. Individual Evaluation—Evaluate each crew member annually on the "Work Appraisal" Form

IV. Verbal Summary: Crew is doing average work. Safety procedures were being followed. Crew needs more training on equipment use.

M Ferris
(Worker)

(Approve) Disapprove This Evaluation _____ (Supervisor)

Figure 7-4—Here is a sample form for reporting the inspection of window maintenance. A full-size version of the form is available in the Management Tools Appendix.

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WORK APPRAISAL FOR

[X] Annual
[ ] Special
[ ] Probationary
[ ] 1st mo. [ ] 2nd mo. [ ] 3rd mo.
[ ] 4th mo. [ ] Special [ ] Special

Name Jones
Classification Custodian
Period from Jan 1, 1995 to Dec 31, 1995

I. Performance Appraisal (rate each item by selecting the phrase most closely describing the employees actual work performance).

1. Job Knowledge
a. Area work
[ ] Needs more training and experience
[ ] Able to perform most of the work
[ ] Knows enough to get by
[X] Able to perform all work well
[ ] Able to perform most of the routine work
[ ] No experience in past year

b. Floor work
[ ] Able to perform most of the routine work
[ ] Needs more training and experience
[X] Able to perform all work well
[ ] Able to perform most of the work
[ ] Knows enough to get by
[ ] No experience in past year

c. Public function setups
[ ] Able to perform all work well
[X] Able to perform most of the routine work
[ ] Able to perform most of the work
[ ] Needs more training and experience
[ ] Knows enough to get by
[ ] No experience in past year

d. Window washing
[ ] Knows enough to get by
[ ] Able to perform all work well
[ ] Needs more training and experience
[X] Able to perform most of the work
[ ] Able to perform most of the routine work
[ ] No experience in past year

2. Ability to Improve
[ ] Has mastered all duties of the position and still has the capacity to do more
[ ] Unable to do most of the routine work
[ ] Lacks ability to perform the work required by the position
[X] Has mastered most of the duties and still has the capacity to do more
[ ] The routine work is the best that can be done and it causes trouble sometimes

3. Quantity of Work
[ ] Has difficulty in organizing time in order to produce acceptable quantity of work. Has to be told what to do most of the time
[ ] Self-starter—makes above average use of work time
[ ] Needs prodding or work time will be unproductive
[X] Makes average use of work time and achieves average quantity of work
[ ] Self-starter—makes outstanding use of work time

4. Quality of Work
[ ] Work is outstanding, rarely find items that need improvement
[X] Work is above average, rarely find examples that have been skipped or neglected
[ ] Quality of daily and periodic work is average
[ ] Weekly checks are necessary
[ ] Daily checks are necessary

5. Attitude Toward Work
[X] Appreciates help and criticism
[ ] Downgrades the school and many of the employees
[ ] Does what is expected
[ ] Respects the school and his position in organization
[ ] Just another job—makes caustic remarks

6. Initiative
[ ] Little evidence of initiative noticed during working hours
[ ] Develops solutions to problems
[ ] No indication of initiative during working hours
[X] Develops workable solutions to most problems on his own but keeps supervision informed
[ ] Relies on others but follows suggestions

7. Loyalty
[ ] Critical of the school
[ ] Willing to talk about the school in a positive way
[ ] Inclined to be one-sided and negative about the school
[X] Self-starter, always willing to explain the school in a positive way
[ ] If others chase, he will talk about the school in positive terms

8. Personality
[ ] Talker but seems to get along with others
[ ] Quiet but gets along with others
[ ] Gets along with others
[ ] Creates some feelings against self
[X] Respected by others

Work Appraisal continued

9. Dependability
[ ] Average in work production and average attendance record
[X] Above average in work production with a perfect attendance record
[ ] Average in work production with an unexcellent attendance record average of one day sick every two months
[ ] Barely average in work production with an above average attendance record
[ ] Above average in work production with an above average attendance record

10. Accident Prevention
[ ] Talks a lot about safety but doesn't do much about it
[ ] Takes chances
[ ] Works safely most of the time
[X] Sets a good example in safe work habits and encourages others to do the same
[ ] Doesn't take chances but shows little interest in accident prevention

11. Physical Makeup
[ ] Complains that work is too hard and the job is too large
[ ] Accomplishes work with energy to spare
[ ] Accomplishes work
[ ] Appears tired most of the time
[X] Accomplishes work easily

12. Cooperation
[ ] Is argumentative
[ ] Always does what is asked
[ ] Seldom voices objections
[X] Always does a little more than is asked

II. General Comments
Health average
Attendance 8 hours in past 12 months
Progress good
Suggestions for self-improvement or development Take supervisory training
Other comments Jones is a sure team worker who is willing to help others

Jan 5, 1996 (Date)
M Harris Signature of person making work appraisal

III. Comments or suggestions by shift supervisor continues the fine work

IV. Comments or suggestions by other members of office supervision will visit to know when more supervisory training will be conducted

This work appraisal has been discussed with me
Jones (Signature of employee)
January 5, 1996 (Date)
M Harris (Signature of person explaining work appraisal)

Figure 7-5—Here is a sample work appraisal form. A full-size version of the form is available in the Management Tools Appendix.

Sample inspection reports are presented in the Management Tools Appendix. *Figure 7-4* shows how one such form might look when filled out.

In addition to the examples provided, some school districts effectively use "occupant reports" to help determine how teachers and others feel about the level of maintenance services. Such reports may or may not depend upon a particular form. If a form is desired, it is best developed locally.

Work Appraisal

Every custodian should receive a formal work appraisal at least once a year. The appraisal should be used to help workers improve their work, and should not be used as a basis for merit salary increases. A Work Appraisal Form is provided in the Management Tools Appendix.

Figure 7-5 shows how a work appraisal form might look when filled out.

The appraisal should include job knowledge, quality of work, and such factors as initiative, loyalty, attitude, and so forth. Attendance is an important indicator of reliability.

Supervisors should discuss appraisals with employees, pointing out where improvements can be made and complimenting good work.

Controls and Reports

In even the smallest school operation, some form of control is essential to see that work is properly and fairly assigned and that it is completed satisfactorily. While much of this is accomplished through personal supervision and inspection, accurate communication and record keeping depends heavily on an efficient system of written instructions and reports.

It is possible to rely too heavily on written reports. Such reports, for example, are no substitute for positive personal interaction between the supervisor and those who work for him. The human element is essential in such aspects of supervision as training, instructing, and correcting. Moreover, excessive use of written reports becomes counterproductive whenever the time spent filling out a form becomes greater than the

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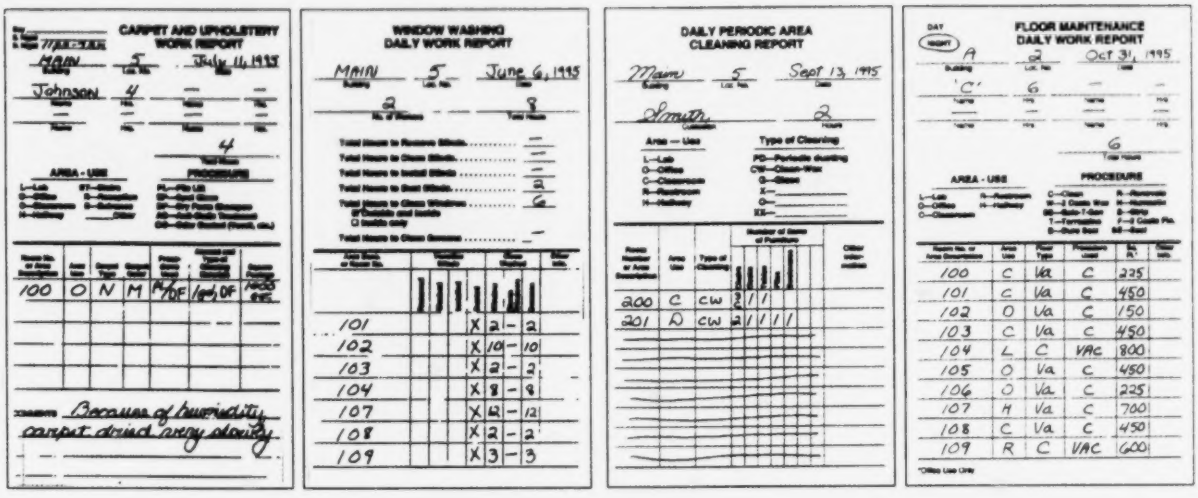

CARPET AND UPHOLSTERY WORK REPORT

WINDOW WASHING DAILY WORK REPORT

DAILY PERIODIC AREA CLEANING REPORT

FLOOR MAINTENANCE DAILY WORK REPORT

Figure 7-6—Here is how some daily and periodic work reports might look when filled out. Full-size forms are available in the Management Tools Appendix.

time saved by increased control.

There are, however, certain kinds of reports which are extremely useful in getting routine information to and from members of the maintenance team. These reports save time, provide information essential to effective management control, and need not be a burden on the total team effort if everyone understands how and why they are used.

Experience shows that the following report forms are effective in most school maintenance operations:

- Custodial Area Assignment (see *Figure 7-3*)
- Work reports (daily or periodic) for area cleaning, floor maintenance, window washing, carpet and upholstery work, and supply orders. *Figure 7-6* shows how such forms might look when filled out.

Forms for these reports are provided in the Management Tools Appendix.

CREATING A LOCAL HANDBOOK FOR CUSTODIANS

Every school district should have its own handbook for use by individual members of the custodial staff. The local handbook forms the basis for training programs for custodians and should be used by all employees as a daily reference in performing their jobs.

This section of *Good School Maintenance*—"Cleaning and General Building Services"—contains most of the material needed to produce a handbook tailored for local use. For a typical local handbook, materials provided here can be adapted to provide such information as the following:

1) Introduction and statement of professional standards. See samples in *Figure 7-7*.

2) Statement of overall maintenance policy. This policy states the board of education's goals and objectives for the maintenance program and provides managers with firm guidelines for planning work to be done. It must be developed locally. The handbook may also include specific policies or regulations regarding use of school property, lost and found items, and other important matters. *Figure 7-1* (page 35) presents a typical school board policy. *Figure 7-8* (page 44) suggests some sample regulations on specific matters.

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INTRODUCTION FOR A CUSTODIAL HANDBOOK

This handbook has been prepared by _____ School District for use by all members of the custodial staff. It includes material of a general nature, such as standards of professionalism, skill and training expected of custodial workers, and general operating matters. It also includes essential reference materials, including copies of forms for reporting work done and repairs needed, as well as sections defining terms often encountered in custodial work and descriptions of the equipment and supplies commonly used. The two sections entitled "Area Cleaning Programs" and "Procedures-Services" provide step-by-step instructions for efficient, productive work, and should be followed as closely as possible. The instructions include realistic time guidelines that should be met as a general rule. From time to time, circumstances may make it impossible for the instructions to be followed exactly or for time guidelines to be met. If such changes in the written instructions are necessary on a regular basis, the supervisor should be consulted.

All members of the custodial/maintenance staff should review this manual regularly and use it as a guide in carrying out their assignments.

STATEMENT OF PROFESSIONAL STANDARDS

The "face" the schools show to teachers, students and visitors depends upon the work you do. Many visitors will receive their entire impression of the schools from the standards of cleanliness and orderliness maintained by the custodial staff. More importantly, the effectiveness of the educational program depends largely upon safe, orderly surroundings that allow students and teachers to concentrate upon their work.

You are a member of a professional team whose difficult job it is to achieve the highest possible standards of cleanliness and maintenance with limited resources.

Because of this, it is essential that every member of the custodial team take a professional attitude that will result in a high level of productiveness and efficiency.

Professionalism includes the following qualities:

Job knowledge—This is based on the initial training you received and the continuing training opportunities that will be made available to you. It includes skills needed to use supplies and equipment, but it also includes ability to manage time and to exercise judgment in following instructions.

Dependability—Dependability includes being on time for work, giving a full day's work, proper reporting, and fair use of benefits. It also includes efficient use of time to complete a job as quickly and thoroughly as possible, following organizational policies and rules and working safely. The custodial worker is part of a team, and the efficient operation of the team depends upon the reliability of each member.

Attitude—The professional takes a positive attitude toward his or her work, and toward the organization. Attitude includes interest in the job, initiative in making suggestions and improving work, and loyalty to the school. A positive, professional attitude is essential for the worker who wants to grow and to advance in the job.

Initiative—The professional custodian must be prepared to exercise judgment and adapt procedures and working patterns to deal with the unexpected. For example, if an area to be cleaned is in use, another area may be cleaned first. Such 'emergencies' as broken glass, spilled liquids or other hazardous conditions must be dealt with frequently. Any regular or major changes in assignment must be discussed with the supervisor, but day-to-day alterations made to cope with special circumstances should be made at the judgment of the custodian.

In addition, professional workers will use initiative to suggest improvements in procedures that will save time or money, and will look for ways to upgrade standards of maintenance using existing resources.

Figure 7-7—Here are examples of an "Introduction" and a "Statement of Professional Standards" that can be adapted for the local custodial handbook.

3) Area cleaning programs. The step-by-step programs suggested in Chapter 8 should be given several "trial runs" and necessary modifications in procedures and time guidelines should be incorporated into the local handbook.

4) Procedures and services. Material in Chapter 9 should be modified and incorporated as suggested above.

NOTE: Area Cleaning Programs and Procedures-Services may be printed on heavy cards, punched and hung on a ring or hook from the custodial cart for convenient reference.

5) Equipment and supplies. See Chapter 10 for material that can be adapted for the local handbook.

6) Glossary of terms. See Chapter 11.

7) Landscaping and Grounds Maintenance. See Section Four; modify if necessary.

8) Forms. See the Management Tools Appendix. These forms may be copied in bulk or modified and reprinted for local use. Local handbooks should include samples of the forms along with instructions for using them. Reporting instructions must be developed locally.

CUSTODIAL REGULATIONS

Bulletin boards

The custodian is responsible for keeping bulletin boards neat and orderly, removing all outdated material at regular intervals. Signs and other notices are to be posted on bulletin boards only—never on doors, glass or walls.

Lost and found

All items of value found in public areas (such as classrooms, hallways or rest rooms) are to be tagged and turned in to the supervisor daily. Lost and found items are not to be stored on the custodial cart or in custodial storage areas. See *Figure 7-9*.

Telephones

School telephones are to be used only for school business except in cases of emergency. Personnel should not be called to the telephone for incoming personal calls, but should be notified of the call.

Ordering and delivering supplies

Cleaning supplies and materials are ordered and delivered on an established schedule which is posted in the custodial storage room.

Supplies should be stored as follows:

Upper shelves: cloth and/or paper towels, toilet tissue, sanitary bags, other paper items.

Middle shelves: dusters and mopheads, chalk, cheesecloth, erasers and so forth.

Lower shelves: Liquid products.

This arrangement protects dry materials from liquid spills or leaks. Keeping the storage room clean is the responsibility of everyone using the area.

Building security

Buildings are to be locked and unlocked at the appointed hours.

All windows are to be closed and locked as the custodian cleans the area. Blinds are to be left at an even height.

Interior doors are to be left locked or unlocked in accordance with school district policy and/or the instructions of occupants.

No one is to be allowed into a locked area without authorization.

All office transom windows are to be screwed shut or blocked.

All school equipment is to be inventoried and numbered. Inventory should be updated once a year.

Locks should be changed periodically, and keys signed out to users and recalled when personnel leave.

Money and other valuables should never be left unattended.

The last person to leave an area is responsible for securing the area and locking the door.

(**Note:** Cleaning scheduled at night or on weekends will enhance building security.)

Personal use of school property

Board of Education policy provides that no one connected with the school in any capacity shall use any school property for personal purposes and that no one shall be permitted to remove from the building or grounds any property belonging to the school—even though it may seem to be of no value—unless it is temporarily removed in accordance with some well-established regulation or with the approval of the appropriate administrator.

The rule is intended to cover all types of school property, including vehicles and general supplies.

Figure 7-8—The local custodial handbook should include all applicable regulations, such as the examples suggested here.

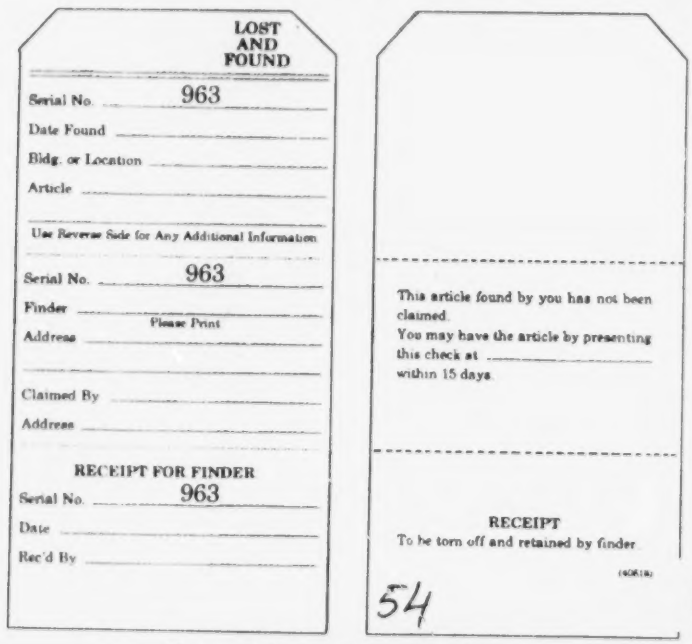

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Figure 7-9—Lost and found tags.

8 / Area Cleaning Programs

The typical school maintenance team must establish programs for cleaning and maintaining the following areas:

- cafeteria
- classrooms
- corridors
- entrances
- gymnasium
- laboratories
- library, music or band rooms
- locker and shower rooms
- offices
- rest rooms
- shops
- stairways
- swimming pools

This chapter presents suggested programs for daily and periodic cleaning in each of these 13 areas. Thus, it can be used both as a reference for individual custodians and as a guide for work planners and supervisors.

Note that there are two ways to approach work schedules for these various areas. One approach is to combine all tasks that must be repeated daily with a number of tasks that must be repeated less frequently (such as weekly or monthly). Thus, a number of periodic tasks get done each day along with all routine daily tasks.

The second approach is to schedule periodic tasks completely separate from daily tasks, so that all light fixture cleaning is done one week, all carpet care the next week, and so forth.

Combining periodic tasks with daily cleaning is probably the more common approach, but experimentation should show which approach is more efficient.

Area cleaning programs will represent a compromise between the desired level of maintenance and the work force available. Few schools have the resources to maintain an ideal level of cleanliness and maintenance. Thus, available resources must be used most efficiently.

Managers can begin with daily and weekly work schedules based on the area cleaning programs described here. These schedules should be used experimentally for a week or more, with workers asked to recommend modifications. In many cases, schedules or procedures must be modified to meet individual circumstances.

Keep in mind that special circumstances, such as a long period of heavy ice and snow, may force a reduction in regular cleaning procedures so that custodians can deal with the emergency. Smaller emergencies can be expected to arise frequently, and schedules must be flexible enough to accommodate these.

For the custodian using this chapter as a reference, the first step is to look up the cleaning program for the desired area. The program described here lists all of the tasks and procedures normally associated with each area. Some of the tasks may not be applicable in a particular school; other tasks may need to be added. In any case, it is essential for the custodian to know all of the tasks required.

The second step is to find the specific procedures and services necessary to complete the tasks in each area. The numbers in parentheses after each task refer to the appropriate sections in Chapter 9/Procedures and Services, where more detailed steps for carrying out various tasks are explained. Turn to Chapter 9, find the num-

Area Cleaning Programs, original chapter by Jack T. Harroun, University of Illinois (retired). Third Edition review and update by John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School, and William C. Bradley, of C & W Bradley, P.C.

bered section, and note the procedures described and the equipment and supplies needed for each job. Also note any safety or other precautions cited.

The custodian can then assemble the materials needed for all of the tasks involved in the daily or periodic cleaning program. The custodian also should note any modifications to the cleaning program that would make it more suitable for local circumstances.

Here are the 13 area cleaning programs:

CAFETERIA CLEANING PROGRAM

In some areas, standards for cafeteria cleanliness may be set by local or county regulations. Be sure to be aware of any such regulations.

Time Guidelines for Typical Cafeteria

Policing and pick-up after meal: 1/2 to 1 hour
Thorough daily cleaning: 2 to 3 hours

Daily Cleaning

(Numbers in parentheses refer to procedures sections in Chapter 9.)

After each serving of food:

1) Clear and clean tables and other equipment and furniture.

2) Place movable equipment and furniture to one side of room or remove to another area.

3) For carpeted floors: vacuum (1-2); clean (5-3) as needed.

4) For uncarpeted floors: sweep (6-2).

5) Replace equipment and furniture.

6) Remove trash (16-1).

After final serving of food for the day:

1) Bring appropriate scrubbing equipment and supplies to room.

2) Clear and clean tables, chairs and other equipment and furniture.

3) Place movable equipment out of the way.

4) Dust (4) or wash (15) flat surfaces and about one-fifth of the vertical surfaces in the room.

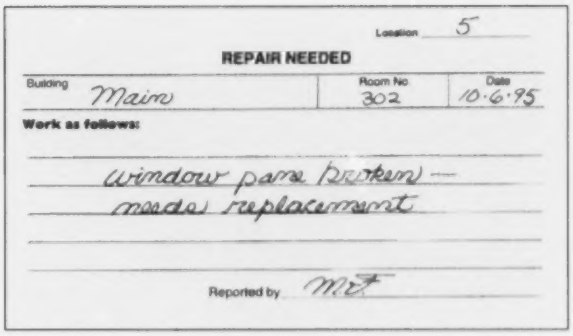
5) While dusting, close and lock windows and adjust window blinds to a uniform height.

6) Empty all trash containers (16-1).

7) Clean carpeting as appropriate: vacuum (5-2) and periodic procedures (5-3).

8) Clean uncarpeted floor using appropriate methods: sweeping (6-2), damp or wet mopping (6-4), machine scrubbing (6-6), buffing or refinishing (6-7).

Note: Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.


Location 5

REPAIR NEEDED

Building	Room No.	Date
Main	302	10·6·95

Work as follows:

window pane broken — needs replacement

Reported by MT

Figure 8-1—The custodian should report any repairs needed. Here is a sample form to make reporting easy. A full-size version is available in the Management Tools Appendix.

9) Remove cleaning equipment, then look over for neatness and cleanliness.

10) Check lights and replace burned-out bulbs (8) or check to see if enough bulbs have burned out for mass replacement.

11) Report any repairs needed. (See *Figure 8-1.*)

12) Turn off lights and lock door if so instructed.

Periodic Jobs

It is recommended that some time be set aside in each daily or weekly schedule for a portion of the following work:

1) Periodic carpet care (5-3): one to three times per week.

2) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile.

3) Wall washing and painting (15): schedule so all walls are washed once in three years and repainted once in five years.

4) Light fixture washing (9): as needed.

5) Washing exterior windows (18): twice a year.

CLASSROOM CLEANING PROGRAM

Time Guideline

Fifteen to twenty minutes per typical school classroom for regular daily cleaning.

Daily Cleaning

(Numbers in parentheses refer to procedures sections in Chapter 9.)

1) Usually classrooms are not locked; however, those containing valuable equipment may be.

2) Turn on lights if necessary, and move custodial cart into room, near chalkboard.

3) Wash chalkboard or marker board, clean erasers and tray, replenish chalk supply (1 or 2).

4) Dust all flat surfaces and about one-fifth of vertical surfaces (4). Establish a routine of dusting certain vertical surfaces each day, so that all are cleaned regularly.

5) While dusting, close and lock windows and adjust blinds to a uniform height.

6) While dusting, empty all waste containers, including wastebaskets and pencil sharpeners

7) Move cart back into hallway.

8) Vacuum carpeting (5-2); or

9) Dust mop floor (6-3). If chairs are movable, move out of the way as you mop, then line chairs up neatly. If room is large enough, move all chairs out of the way, dust mop the entire area, then replace chairs. If floor covering is tile, use lines to line up chairs evenly. If seats are fixed, edge mop to the furthest corner from the door, then mop the floor halfway into the seating aisle. Bring dust out to the main aisle, working from back of room to front. Mop front of room, then move back along opposite side of room.

10) Report any damaged or missing asbestos floor tile to the designated person in your school.

11) Pause at doorway and look over area for neatness and cleanliness, using the following checklist:

- All lights burning?
- Windows closed and locked?
- Chairs in orderly rows?
- Chalkboards or marker boards washed?
- Supply of chalk and erasers adequate?

12) Listen for unusual noises, such as hissing air or noisy motors. Report any problem to supervisor.

13) Turn off all lights.

14) Close and lock door, if found locked.

15) Either shake mop in hallway or edge hallway to next room and pick up dirt following cleaning of that room.

16) Make or report needed repairs.

17) Replace burned out lamps (8).

Periodic Jobs

1) Periodic carpet care procedures (5-3): one to three times a week.

2) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile.

3) Wall washing and painting (15): all walls should be washed once in three years, repainted once in five years.

4) Light fixture washing (9): as needed.

5) Washing of exterior windows (18): as needed.

CORRIDOR CLEANING PROGRAM

Time Guideline

Five to ten minutes per 1,000 square feet of typical school corridor.

Daily Cleaning

1) Dust hallway, including flat surfaces, tops of display cases and chair rails (4).

2) Clean some interior glass (door glass, display glass, etc.) so that all is cleaned once a month (7).

3) Edge hallway with dust mop while moving from room to room.

4) Dust mop entire floor (6-3) or vacuum carpeting (5-2).

5) Shake out dust mop and pick up dirt (6-3).

6) If needed, damp mop spots on hallway floor. In bad weather, whole corridor may need to be damp or wet mopped (6-4).

7) Check for burned-out lights and replace (8).

8) Report repairs needed.

Periodic Jobs

1) Carpet care (5-3): one to three times a week.

2) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.

3) Wall washing and painting (15): walls should be washed once in three years and repainted once in five years.

4) Light fixture washing (9): as needed.

5) Washing of exterior windows (18): as needed.

ENTRANCE CLEANING PROGRAM

Time Guideline

Five to ten minutes.

Daily Cleaning

1) Sweep outside entrance ramp and steps

down to main sidewalk.

2) Pick up dirt, trash, and leaves.

3) Clean both sides of door glass (7).

4) Lock or unlock doors at appointed times.

5) Replace burned-out entrance lights (8).

6) Dust mop (6-3) or wet mop (6-4) floor as needed.

7) Vacuum (5-2) entrance mats as needed.

8) Report repairs needed.

Periodic Jobs

1) Carpet care (5-3): one to three times per week.

2) Floor refinishing (6-7): as needed.

3) Wall washing and repainting (15): every three to five years as needed.

4) Light fixture washing (9): as needed.

5) Snow and ice removal (12): as needed.

Special Note

Large savings in labor and floor surfaces can be achieved through the proper treatment of entryways. Studies show that 15 to 20 feet of walk-off mats stop 85 percent of the dirt typically tracked into a school. It pays, therefore, to keep sidewalks clean and in good repair and to provide mats both inside and outside the doorway.

GYMNASIUM CLEANING PROGRAM

Time Guideline

Thirty to sixty minutes per typical gymnasium, including seating area.

Daily Cleaning

1) Unlock door, turn on lights if necessary and move custodial cart into area.

2) If there are chalkboards, clean them (2).

3) Dust all flat surfaces and about one-fifth of the vertical surfaces (4).

4) While dusting, check, close and lock windows and adjust blinds to uniform height.

5) While dusting, check waste containers and collect and remove trash (16-1).

6) Place movable equipment or furniture to one side or in another area.

7) Dust mop seating area. Collect soil at one or more points for pickup, depending on size of area (6-3).

NOTE: Not all types of floor can or should be dust mopped. For carpeted floors, see Procedure 5-1 in Chapter 9. For floors covered with PVC vinyl, urethane, or other chemical composition, follow procedures recommended by the manufacturer.

8) Dust mop rest of floor. Be sure dust mop conditioner is compatible with wood finish. Check manufacturer's directions.

9) Remove soil (6-3).

10) Replace furniture and equipment.

11) Check for burned-out light bulbs and replace as needed, or check to see whether enough are burned out for mass replacement (8).

12) Remove cleaning equipment and pause to check area for neatness. Listen for unusual sounds, such as hissing or noisy motors.

13) Report any repairs needed. (See *Figure 8-1.*)

14) Turn off lights before leaving area and lock door if so instructed.

Periodic Jobs

1) Floor refinishing (6-8): as needed.

2) Wall washing and repainting (15): walls should be washed every three years, repainted every five years.

3) Mass light bulb replacement (8): as needed.

4) Light fixture washing (9): as needed.

5) Washing of exterior windows (18): twice a year.

LABORATORY CLEANING PROGRAM

Be especially careful when working around chemicals and laboratory apparatus. If in doubt, do not clean or disturb the area. **NEVER** attempt to clean up spilled chemicals without checking with person in charge of area. (See Procedure 3 in Chapter 9.)

Time Guideline

Fifteen to twenty minutes per typical school laboratory.

Daily Cleaning

1) Unlock door. In most cases, laboratory doors are kept locked. If door is found unlocked, make a mental note to consult supervisor.

2) Before turning on lights, smell for the pungent odor of gas. Look over the area for problems such as chemical spills.

3) Move custodial cart into room if possible. If not, take a collector can into the room.

4) Wash chalkboard or marker board (1 or 2):

however, if there is any doubt about whether material on board should be erased, leave it. Clean chalk trays and erasers, replenish chalk supply.

5) Dust flat areas that are accessible and do periodic dusting scheduled for the day (4). **DO NOT** dust areas cluttered with chemicals or apparatus.

6) While dusting, empty wastebaskets and pencil sharpeners. Be especially careful when emptying wastebaskets, because trash may include chemicals (16-1).

7) Close and lock windows and adjust blinds to uniform height.

8) Check paper towel dispensers and replenish supply if necessary (13).

9) Return custodial cart or collector can to hallway.

10) Dust mop entire floor (6-3).

11) Look over area for neatness and cleanliness.

12) Check to see that all lights are burning. Replace bulbs if needed (8).

13) Listen for unusual noises, such as running water, hiss of steam, gas or air, or noisy machinery.

14) Turn off lights, close and lock door.

15) Shake dust mop in the hallway and pick up dirt or edge hall to next room.

16) Report repairs needed.

Periodic Jobs

1) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.

2) Wall washing and painting (15): walls should be washed every three years and painted every five years.

3) Light fixture washing (9): as needed.

4) Washing of exterior windows (18): twice a year.

LIBRARY, BAND OR MUSIC ROOMS

Time Guidelines

Daily cleaning for each special use area: 20 to 40 minutes.

Daily Cleaning

1) Special use areas usually are locked because they contain valuable equipment.

2) Before turning on lights, smell for leaking gas. Move custodial cart into the room.

3) If there is a chalkboard or marker board, move custodial cart nearby and wash it. Also clean erasers and tray. Replenish chalk supply (1 or 2).

4) Dust all flat surfaces and about one-fifth of the vertical surfaces (4).

5) Check with occupant on dusting detail, because some occupants will dust the specialized equipment and perhaps the entire area. If not, establish a routine of dusting certain vertical surfaces each day so that all surfaces to be dusted are cleaned regularly.

6) While dusting, close and lock exterior windows, adjust blinds to a uniform height and check waste containers to see if they need emptying.

7) Empty all waste containers, including waste baskets and pencil sharpeners (16-1).

8) Move cart back into the hallway.

9) Dust mop floor (6-3) and/or vacuum carpet (5-2).

10) Pause at the doorway and review the area for neatness and cleanliness. Use the following checklist:

- All lights burning.
- Windows closed and locked.
- Window blinds at uniform height.
- If appropriate, chairs or other similar furniture in orderly rows.
- Chalkboards or marker board cleaned.
- Adequate supply of chalk and erasers.

11) Listen for unusual noises, such as hissing air or gas or noisy motors and report any problem to your supervisor.

12) Turn off lights.

13) Close door and leave it locked or unlocked in accordance with district policy.

14) If the floor area was dust mopped, either shake the mop in the hallway or edge hallway to the next room and pick up the accumulated soil when it fits into the sequence of daily cleaning.

15) Make report on needed repairs. (See *Figure 8-1*)

16) Replace burned out lights on a schedule provided by supervisor (8).

Periodic Cleaning

1) Carpet care (5-1): daily if possible, but at least one to three times a week depending on use of area.

2) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.

3) Wall washing and painting (15): all painted walls should be washed once every three years, repainted once every five years or on a schedule

that meets the need.

4) Light fixture washing (9): as needed.

5) Washing of exterior windows (18): as needed.

LOCKER AND SHOWER ROOM CLEANING PROGRAM

Time Guideline

Fifteen to thirty minutes per typical locker room or shower room.

Daily Cleaning

1) Unlock door, if locked. Turn on lights and move custodial cart and cleaning supplies into room, as close as possible to work area.

2) Dust all flat surfaces and do about one-fifth of the vertical surfaces and other periodic dusting (4).

3) While dusting, close and lock windows.

4) Check waste containers and remove trash (16-1).

5) Check supplies of soap, towels, toilet tissue (13).

6) If necessary sweep floor (6-2) or pick up debris.

7) Check lights and remove burned out bulbs (8).

8) Remove graffiti and spot clean walls and partitions as needed (14).

9) Clean fixtures (11) in following order: mirror, soap dispenser (13), wash basin, towel cabinets, shower walls and shower heads, locker room benches, lockers (outside), urinals, stools, sanitary cans.

10) Remove movable furniture or equipment.

11) Either wet mop (6-4) or machine scrub (6-6) floor. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.

12) Replace movable equipment or furniture.

13) Report any repairs needed.

14) Remove cleaning equipment and look over area for cleanliness. Listen for any unusual sounds from equipment or drains.

15) Turn off lights and lock door if so instructed.

Periodic Jobs

1) Floor refinishing (6-7): as needed.

2) Wall washing and painting (15): walls should be washed every three years, repainted every five years.

3) Washing of exterior windows (18): twice a year.

4) Light fixture cleaning (9): as needed.

OFFICE CLEANING PROGRAM

Time Guideline

Six to twelve minutes per typical office.

Daily Cleaning

1) Unlock door and make a mental note if door was unlocked. Most office doors are kept locked. Turn on lights.

2) Move custodial cart or collector can into room. Keep collector can as close to work area as possible to eliminate steps and doubling back.

3) Clean chalkboard or marker board if needed (1 or 2). Check chalk and eraser supply.

4) Dust all flat surfaces and do about one-fifth of periodic dusting (4). A typical schedule for periodic dusting might be: Monday, chair rounds; Tuesday, baseboards; Wednesday, sides of file cabinets; Thursday, other vertical surfaces; Friday, overhead dusting.

5) While dusting, empty all waste containers, including wastebaskets, ash trays and pencil sharpeners (16-1).

7) Take cart or collector can out of room.

8) Dust mop floor (6-3).

9) While dust mopping, replace chairs.

10) If floor is carpeted, use upright vacuum to clean traffic lanes three times a week and remove trash from unvacuumed areas. Once or twice a week, thoroughly vacuum all accessible floor areas, moving only chairs and other light furniture (5-2).

11) Look over room for neatness.

12) Check for burned out bulbs and replace (8).

13) Shake dirt from dust mop in hallway and pick up dirt or edge hallway to the next room to be cleaned.

14) Turn off lights and lock door, if found locked.

15) Report repairs needed.

Periodic Jobs

1) Carpet care (5-1): as needed.

2) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school.

3) Wall washing and painting (15): all walls

should be washed every three years and painted every five years.

4) Light fixture washing (9): as needed.

5) Washing of exterior windows (18): twice a year.

REST ROOM CLEANING PROGRAM

Time Guideline

Multiply number of fixtures by three minutes.

Daily Cleaning

1) If rest room is for persons of opposite sex, knock on door and call out "custodian" before entering.

2) Move custodial cart inside door if possible.

3) Dust all flat surfaces and do about one-fifth of periodic dusting (4).

4) While dusting, empty waste containers (16-1).

5) Note need for supplies such as toilet tissue, towels and soap. Replenish supplies as needed (13).

6) Sweep (6-2) or dust mop floor (6-3). Sweep soil into hall and pick up.

7) Remove graffiti and spot clean walls and partitions as needed (14).

8) Clean plumbing fixtures in following order:

- mirror (11)
- soap dispenser (13)
- wash basin (11)
- towel cabinets (13)
- urinals (11)
- stools (11)
- sanitary can (11)

Note: Review your school district's biological hazards program periodically for procedures on cleaning up of bodily fluids.

9) Wet mop floor (6-4). Pick up water, leaving floor as dry as possible.

10) Replace burned out light bulbs (8).

Periodic Jobs

1) Floor refinishing (6-7): as needed. **Note:** Check your school's asbestos management plan for the proper protocol for cleaning and stripping of asbestos floor tile. Report any damaged or missing tile to the designated person in your school

2) Wall washing and painting (15): walls should be washed at least once every three years and painted once every five years.

3) Washing exterior windows (18): as needed.

4) Thorough cleaning of room: annual.

5) Light fixture cleaning (9): as needed.

SHOP CLEANING PROGRAM

Time Guideline

Thirty to forty-five minutes for typical school shop area.

Daily Cleaning

1) Unlock door. Before turning on lights, smell for the pungent odor of gas. Move cart into room if possible. If not, move waste container into room as close to work area as possible.

2) Dust open areas (4).

3) Empty trash as you dust (16-1). Test weight of containers before lifting as they may contain heavy wood or metal shavings.

4) Close and lock windows, adjust blinds to uniform height.

5) Sweep (6-2) or dust mop (6-3) area. Pick up soil in hallway.

6) Look over room for neatness.

7) Check to see that all lights are burning. Replace burned out bulbs as necessary (8).

8) Listen for unusual noises. Check to see that all machines have been turned off.

9) Turn off lights and close door. Leave door locked or unlocked in accordance with district policy.

10) If soil was not picked up, edge hallway to next room to be cleaned.

11) Report repairs needed.

Periodic Jobs

1) Floor refinishing (6-7): as needed.

2) Wall washing and repainting (15): all walls should be washed every three years and painted every five years.

3) Light fixture washing (9): as needed.

4) Washing of exterior windows (18): twice a year.

STAIRWAY CLEANING PROGRAM

Time Guideline

Five to eight minutes for each section or flight of stairs.

Daily Cleaning

1) Dust one side of stairway up to next floor. Dust other side on way down (4).

2) While dusting, check stairs for foreign objects.

3) Take dust mop to stair landing on floor above and dust mop stairs going down (6-3).

4) Be careful when backing down stairs to be

aware of last step. Do not knock debris onto floor below when mopping open stairways.

5) Shake mop in lower hallway and pick up dirt or edge hallway to next room, then shake mop.

6) Check hall area for burned-out light bulbs and replace (8).

7) Report repairs needed.

SWIMMING POOL MAINTENANCE GUIDE

Swimming pool maintenance is governed in large measure by state statutes and regulations. The governing document in Illinois is the "Illinois Swimming Pool and Bathing Beach Code" (77 Illinois Administrative Code 820). It is available from the Illinois Department of Public Health, Division of Environmental Health, Office of Health Protection. Section 820.340 covers Operation and Maintenance.

Supplies and Equipment Needed

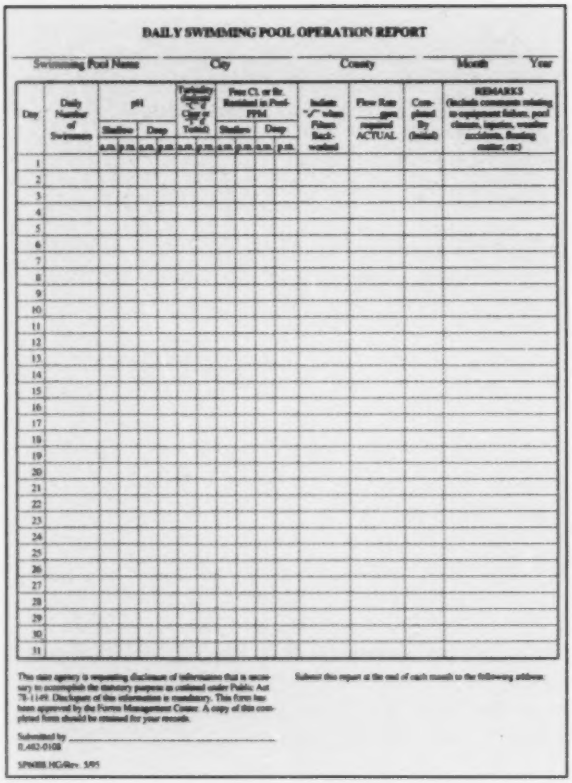
Rubber boots
Goggles or face shields
Rubber gloves
Plastic buckets
Scrub brushes with handles
Nylon push brooms
Scrub pads and holder
Automatic scrubber
Pressure sprayer
Appropriate-sized stepladder
"Closed—Maintenance" signs
Mop handles
Cotton mopheads
Gear press mop units
Automatic pool cleaner
Hand skimmers

General Procedure

Mechanical equipment for swimming pool maintenance and operations should be maintained according to the manufacturer's instructions and approved codes, such as the National Electrical Code and all state and local codes.

Figure 8-2 shows a daily swimming pool report that is typical. Periodic reports also are usually required on forms specified by most state departments of public health.

Swimming pools differ in design and operation. The following guidelines should be modified and a maintenance procedure developed for each pool.



DAILY SWIMMING POOL OPERATION REPORT

Swimming Pool Name _____ City _____ County _____ Month _____ Year _____

Day	Daily Number of Swimmers	pH				Turbidity (Secchi Disc or Clarity Tube)		Free Cl. or Br. Residual in Pool-PPM				Indicate "✓" when Filters Back-washed	Flow Rate ____ gpm required ACTUAL	Cond. by (Initial)	REMARKS (Include comments relating to equipment failure, pool closure, injuries, weather conditions, bather traffic, etc.)
		Shallow		Deep		Clear at ____ ft. Turbid		Shallow		Deep					
		a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.				
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This state agency is requesting disclosure of information that is necessary to accomplish the statutory purpose as outlined under Public Act 79-1149. Disclosure of this information is mandatory. This form has been approved by the Forms Management Center. A copy of this completed form should be retained for your records.

Submit this report at the end of each month to the following address:

Submitted by _____

IL 462-0108

SP4088 HC/Rev. 5/85

Figure 8-2—A typical Daily Swimming Pool Report form.

Cleaning of pools may be divided into daily and periodic tasks.

Time Guideline

Sixty to 90 minutes for a typical pool.

Daily Cleaning

1) Remove equipment necessary for daily cleaning. If area is dry, sweep and pick up debris and place in trash container.

2) Check overflow systems and automatic surface skimmers. Clean if necessary.

3) Remove floating debris from water.

4) Remove debris from bottom of pool.

5) Clean drain gutter if needed.

6) Wash deck area, using hose approved for hot water, spray nozzle or a power sprayer machine, and an approved cleaner.

7) Remove cleaning solution from deck area.

8) Clean and disinfect dressing rooms and shower stalls.

Periodic Cleaning

1) Drain and inspect pool as needed (or as required by public health standards).

2) Perform needed maintenance, such as repair of cracks and chips and repair and replacement of mechanical equipment.

3) Follow manufacturer's instructions to check the following:

- pump
- filters
- disinfectant feeders
- flow indicators
- gauges

4) Clean drain gutter if needed.

5) Clean walls of pool.

6) Clean bottom of pool.

7) Disinfect indoor pool decks at least weekly.

Safety Precautions

Test ground fault electrical outlets (GFI) and water spigots to be sure they are in safe working condition. All equipment used in daily and periodic cleaning should be carefully inspected for safe operation.

9 / Custodial Procedures and Services

Here are detailed instructions for performing common job procedures efficiently and effectively. Experience undoubtedly will dictate modifications to adapt the instructions and the time guidelines to local situations. Procedures are numbered so they can be easily located by custodians and supervisors who are using the Area Cleaning Programs in Chapter 8. The job procedures and services described here are as follows:

1 Dry Marker Boards
2 Chalkboards
3 Chemical or Acid Spills
4 Dusting
5-1 Floors—Carpeted
5-2 Vacuum Cleaning
5-3 Periodic Carpet Care
6-1 Floors—Uncarpeted
6-2 Sweeping
6-3 Dry (Dust) Mopping
6-4 Wet Mopping
6-5 Auto Scrubbing
6-6 Floor Machine Procedures
6-7 Sealing and Refinishing Floors
6-8 Refinishing Wood Gymnasium Floors
7 Glass (Interior)
8 Light Bulb Replacement
9 Light Fixture Cleaning
10 Moving
11 Plumbing Fixture Cleaning
12 Snow and Ice Removal
13 Soap and Paper Dispensers
14 Spot Washing (Graffiti)
15 Wall Washing
16-1 Waste Removal
16-2 Waste Removal—Large Containers
17 Waxing Furniture
18 Window Washing

1 DRY MARKER BOARDS

Job Description and Frequency

Dry marker boards with porcelain finish require very little maintenance or cleaning.

Precautions

- Be sure that only water-soluble markers are used.
- Keep lids on pens so they won't dry out.
- Use rubber gloves and safety glasses when using spot removing solvents.

Time Guideline

1/4 to 1 minute per 50 square feet of board.

Equipment

- Cheesecloth or cloth pads
- Pail of water and sponge (if board is messy)
- Solvent for spot removal

Procedure

- If needed, wipe marker board clean with dry cloth.
- A messy board may be washed with wet sponge and dried.
- If a pen with insoluble ink has been used on the board, remove the ink with spot removing solvent.

2 CHALKBOARDS

Job Description and Frequency

Chalkboards in offices, classrooms and other locations should be washed to remove accumu-

Custodial Procedures and Services, original chapter by Jack T. Harroun, University of Illinois (retired). Third Edition review and update by John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School. New information also has been supplied by William C. Bradley, of C & W Bradley, P.C. (environmental issues); Victor Larson, of Larson Equipment and Furniture Co. (dry marker boards); E.E. Roderick, of Chemical Maintenance, Inc. (carpet care), and Advance Floor Machines (carpet care).

lated dust, unless marked "Do Not Erase" or with similar directions.

Precautions

- Wear protective clothing and rubber gloves, as chalk dust or water can dry and chap hands.
- Be sure the chalkboard surface is designed to be washed with water. Some painted surfaces may be damaged by water.
- Be careful not to splatter papers, furniture, equipment with water.

Time Guideline

- Three to ten minutes per 50 square feet of board.

Equipment

- Two plastic pails
- Four sponges
- Chalk and erasers
- Rubber gloves

Procedure

- Put on rubber gloves (optional but recommended).
- Each pail should be half-full of water. Dip two sponges into one pail and squeeze out excess water so that sponges are wet enough to pick up chalk dust but not wet enough to drip.
- Hold sponges side by side in lower right-hand corner of the chalkboard, and wash the board by pushing the two sponges along the surface in the following pattern:

Step A: Move from lower right-hand corner to upper right-hand corner. Turn sponges 90 degrees and wash upper edge of board. Turn sponges 90 degrees and move from upper left-hand corner to lower left-hand corner, as shown in *Figure 9-1(a)*.

Step B: Turn sponges 180 degrees and wash a vertical strip, overlapping the vertical strip just washed. Turn sponges 90 degrees and wash a second horizontal strip, overlapping horizontal strip previously washed, as shown in *Figure 9-1(b)*.

Step C: Turn sponges 180 degrees and wash the rest of the board in horizontal strips, each time overlapping the previously washed strip, as shown in *Figure 9-1(c)*.

By making the turns as indicated, the leading edge of the sponge remains the same. *Sponges should not be lifted from the board* until about half of the board has been washed. Then they should be turned over, again keeping the leading edge the same.

- After all boards have been washed, lay sponges on chalk tray and run them along the tray, discarding pieces of chalk less than one inch long.

Figure 9-1(a)—In cleaning chalkboard, begin at the lower right hand corner and move sponges to upper right hand corner. Turn sponges 90 degrees to keep the same leading edge and move across the top of the board to the upper left hand corner. Again turn sponges 90 degrees to keep the same leading edge and move down to the lower left hand corner.

Figure 9-1(b)—Turn sponges 180 degrees without lifting them from the board and return to the top of the board, overlapping the area just cleaned. Turn the sponges 90 degrees to the right and return back across the board, again overlapping the clean area.

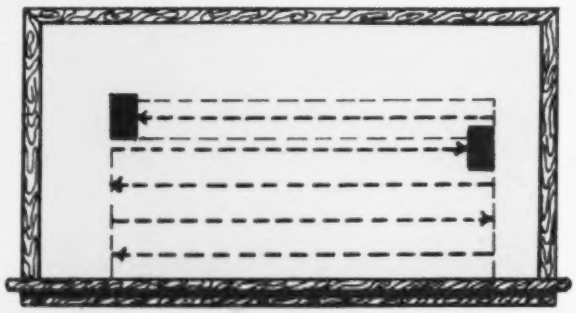


Figure 9-1(c)—Turn sponges 180 degrees and return back across the board, overlapping cleaned area. Continue to turn sponges and move back across the board until the entire board has been cleaned.

• Run the felt side of erasers over the sponges and replace erasers on cleaned tray.

• Put sponges into wash bucket. Squeeze out the two clean sponges in the second bucket. Squeeze rinse sponges drier than wash sponges.

• Rinse boards, following the pattern in Steps A, B and C above.

• Put sponges back in rinse bucket.

• Replenish chalk and erasers as needed. Generally, provide one piece of chalk and one eraser for every four feet of board.

• In the course of the job, replace rinse and wash water as needed.

Storage

At the end of each shift, empty buckets. Rinse buckets and sponges. Refill buckets about half full of water. Leave sponges in buckets. Store on the custodial cart in the locked custodial storage room.

3 CHEMICAL OR ACID SPILLS

Job Description

Cleaning up chemical or acid spills should be done only under proper technical supervision. Consult your school's Hazardous Waste Communications Program. For more information see Chapter 6 on Environmental Issues, especially the sections on Waste Management and Worker Right-to-Know.

Safety Precautions

• A chemical or acid spill can be cleaned up only after the chemical has been neutralized. School district policy should establish who is responsible for properly neutralizing a chemical spill.

• Do not clean any spill if there is reason to suspect it might be acid or some other dangerous chemical. Organic mercury, lead, potassium, sodium and other elements can react violently with cleaning products or can be dangerous in and of themselves. Call the supervisor immediately.

• Leave the area until the spill has been identified.

Time Guideline

Varies widely. Fifteen to 30 minutes may be used as a beginning estimate.

Equipment

• Wet-dry vacuum
• Wet mops
• Mop buckets
• Mop wringer

Procedure

• After chemical has been neutralized, decide whether to use a vacuum (5-2) or wet mop (6-4), depending on size of spill.

• Asbestos, lead dust, sodium, potassium and mercury spills cannot be neutralized. They must be contained by proper procedures.

• Use procedures outlined for the equipment used.

• Supervisor will make a decision as to whether refinishing of the floor area is necessary after a chemical spill.

4 DUSTING

Job Description and Frequency

Removal of dust from equipment and furniture. Proper dusting removes dust, rather than moving it from one location to another. Flat surfaces should be dusted daily. Vertical surfaces may be dusted weekly. Dusting should be scheduled so that the entire area is dusted once a week.

Precautions

• Be careful not to brush dust or dirt into eyes.

• Take care not to knock items off desks, tables, bookcases or window ledges.

• Do not leave a treated duster on a desk or table for any length of time, as it may damage the surface.

Time Guideline

• Varies widely depending on how clear the area to be dusted is. In general: 10 percent or less of area obstructed—5 minutes per 1,000 square feet; 50 percent or more of area obstructed—15 minutes per 1,000 square feet.

Figure 9-2—In dusting a desk, items can be moved, but should not be removed.

Equipment

- Duster handle.
- Short-strand cotton duster.

Procedure

- All desks, tables and similar flat surfaces should be dusted, but normally objects are not removed for dusting. It is the responsibility of the occupant to clear surfaces if they are to be dusted. See *Figure 9-2.*
- Tie treated duster mitt onto the frame. Lay duster flat on surface. Move duster entire length of surface. Be careful to avoid striking any objects. Overlap dusted area with each successive pass as in *Figure 9-3.*
- Dust telephone, areas between tables or desks, chairs and file cabinets. See *Figure 9-4.*
- Laboratory tables and window ledges and other similar areas should be dusted only when there is no equipment there.
- At times, two dusters can be used at the same time, one in each hand, to dust baseboards, chair rails, and grill work on stairs. Care must be taken when two dusters are used at once to avoid hitting objects.
- Dust right to left if right-handed and top to bottom, so dust and litter are brushed onto floor, to be picked up with dust mop.
- If duster is properly treated, one pass over each area is sufficient. When duster becomes too dirty to pick up dust, it should be replaced and returned for laundering and re-treatment.

Care and Storage

- Some duster mitts require no initial treatment as they come from a laundry already treated and packed in a plastic bag. Supplies should not be overstocked as the treated duster mitts will dry out if stored too long.
- If not already treated, the duster should be treated with a small amount of dust controllant.
- Dusters being used may be stored on the custodial cart. Clean duster mitts should be stored on a shelf in a locked custodial storage room. Dirty dusters should be placed in a receptacle in the custodial room. Worn out or torn dusters should be reported or returned to the supervisor for replacement.

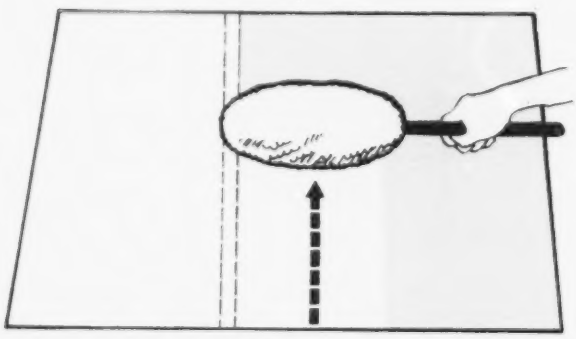


Figure 9-3—In dusting, overlap the clean area to avoid missing any of the flat surfaces.

Figure 9-4—Vertical surfaces, such as chair rails and legs, should be dusted at least once a week.

5-1 FLOORS—CARPETED

Selection

The decision to use carpeting as a floor covering often is based on acoustical values rather than maintenance factors. However, carpeting should be used to trap soil in such areas as entrances or elevators, to enhance prestigious offices, and to reduce custodial costs. When annual man-hours to provide floor care exceeds 60 per 1,000 square feet, carpeting should be considered.

When the decision to carpet is made, it is important to make the right selection. It usually does not pay to install domestic type carpeting on school floors.

Color is another important factor. Under most school conditions, a medium colored carpet with light and dark patterns will maintain the best appearance and require the least maintenance time. Either a light-colored or dark-colored carpet will tend to show soil most readily and require more custodial time to maintain an acceptable appearance.

Carpet density is another factor to consider. A

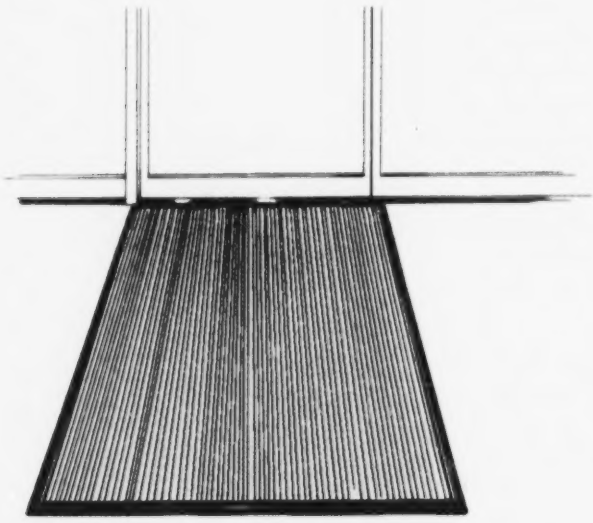


Figure 9-5—Carpet entrance mat catches dirt before it can be tracked further into the building.

carpet made with a loose construction allows soil to penetrate and abrade the fibers. A commercial type carpet is made with the face fiber slightly packed so most of the soil will remain on top where it can be easily removed.

The type of carpet fiber is important. The basic choice is between a natural fiber (such as wool) or a man-made fiber (such as nylon). The recent generation of nylon fiber being used in school carpeting today offers maintenance advantages. It is highly stain resistant and the polypropylene backing retains dimensional stability and is water proof.

It is important to know the fiber so that all cleaning materials are compatible.

Installation also is important: improper installation can cause poor appearance as well as excessive maintenance costs. The glue-down method should be reviewed for school installations, using the adhesive recommended by the manufacturer. The carpet installer should be held responsible for poor installation.

Preventive Maintenance

- Keep as much soil as possible off the carpeting by generous use of entrance mats (see *Figure 9-5*).
- Increase the frequency of carpet care in heavy traffic areas or around food serving areas, such as vending machines.
- Remove spots promptly.
- Use bonnet cleaning or extraction as necessary to remove oily soils from surface.
- Although major manufacturers do not recommend it for general use, consider sprinkling a dry compound cleaner to restore the appearance of worn carpeting in traffic lanes.
- Properly-used anti-static treatments can reduce static electricity (see *Figure 9-6*).

Carpet Cleaning Procedures

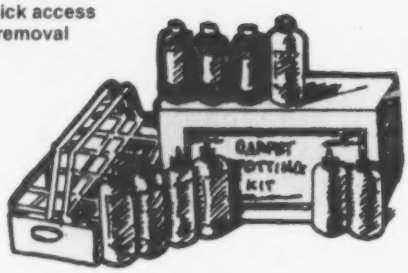
Vacuuming—Unless foot traffic is nil, carpeted areas should be vacuumed daily. Some areas may require vacuum cleaning more than once a day (such as areas near an entrance). An upright vacuum machine is considered best for removing soil from carpeting. (See Procedure 5-2.)

Stain and spot removal—The longer a spill or spot remains on the carpet fibers, the harder it will be to remove. The carpet maintenance program must provide for prompt spot and spill removal. In removing stains, spots and spills, it is important to work carefully so that a larger spot is not caused by the cleaning process. Follow the manufacturer's directions for the product used. (See *Figure 9-7.*)

Periodic cleaning—A number of methods for cleaning soiled carpets are available: bonnet cleaning, dry cleaning, dry foam shampoo, detergent solutions, and water or steam extraction.

Figure 9-6—Anti-static spray is available in several forms.

Figure 9-7—The custodian should have quick access to a kit of spot removal products.



(See Procedure 5-3.) As with vacuuming, frequency varies with the exposure to traffic and other soiling conditions. The cleaning method selected should be based on the carpeting material and the manufacturer's recommendations.

Carpet Repair and Replacement

Delayed carpet repairs lead to early replacement. Promptly repair seams, rips and holes to prolong the life of the carpet. Calculate the approximate replacement time and plan for it.

5-2 VACUUM CLEANING

Also see Procedure 5-1.

Job Description

Regular vacuuming of carpet prolongs life by removing sharp gritty particles that can grind rug fibers.

Precautions

- Be careful not to bang machine against walls, furniture or equipment.
- Never leave machine unattended in public areas.
- Never over-extend your reach in the back-and-forth movement.
- Be careful of electrical outlets in flooded areas.
- Never vacuum any fibers released from asbestos materials. See the designated person in your district when confronted with asbestos.

Time Guideline

Suggested time for 1,000 Square Feet	Dry Vacuum	Wet Vacuum
Unobstructed area:	20 minutes	30 minutes
Moderately obstructed area:	30 minutes	40 minutes
Heavily obstructed area:	40 minutes	50 minutes

Equipment

Various types of vacuum machines are available (see *Figure 9-8*). The choice depends upon the

Figure 9-8—The most common types of vacuum cleaners are the upright (left), the wet-dry vac (top-center), and the tank-type, shown with a variety of attachments.

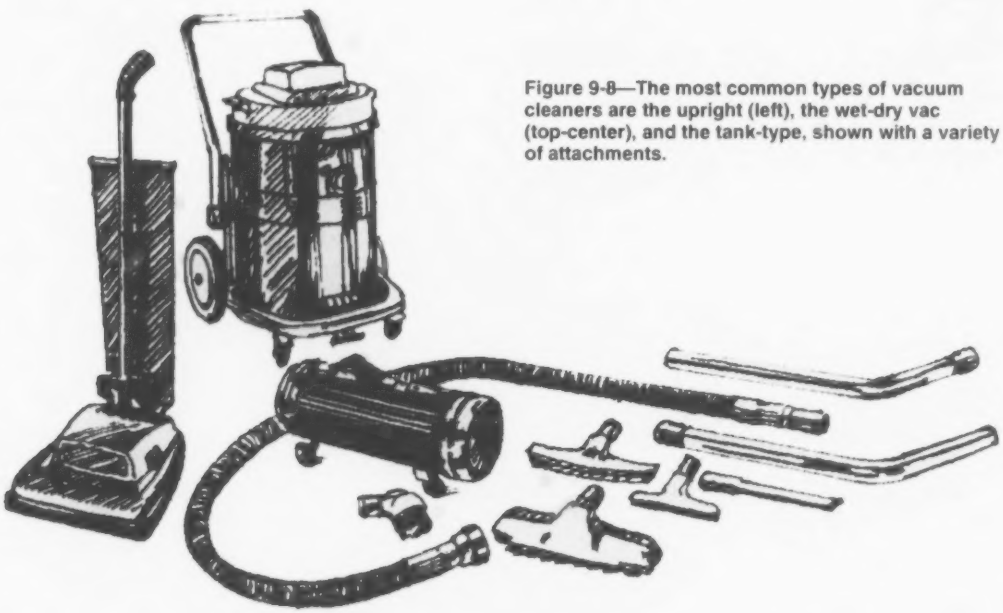


Figure 9-9—Push the vacuum to arm's length. Then return it, overlapping the first pass.

particular job.

- Wet-dry machines are used to remove liquids.
- Upright and brush-type vacuum cleaners are used on carpets to agitate the pile and remove the soil by air movement.
- Tank-type dry vacuum cleaners are used for dusting or carpet cleaning.
- Wide area models, either corded or battery operated, cut vacuuming time in large, unobstructed areas, such as corridors.

Procedure

- One slow movement over the area is better than several fast, short back-and-forth movements. When the flow of air is stopped or obstructed, cleaning action stops.
- Dust room to be vacuumed and empty waste cans before beginning to vacuum carpet.
- Move wastebasket and chairs out of the way (do not place on desks and tables).
- Unwind cord and plug into 110-volt outlet. Starting at doorway turn on vacuum, adjust height of brush and move vacuum forward at arms length. (See *Figure 9-9.*)
- Push the vacuum across the carpet and, overlapping the first pass, return it. Continue this movement until the entire carpet area has been cleaned. Usually one pass over each strip is sufficient.
- After the entire area has been vacuumed, turn off machine, raise brush and unplug and rewind cord.
- Return chairs and wastebaskets to correct position in room.
- In heavily used areas, the walkways may need to be vacuumed a second time. In most areas, daily vacuuming is sufficient.
- Attachments should be used periodically to vacuum hard-to-reach places, such as along baseboards and desks.

Tank-type vacuum—This machine may have a retractable cord. It has a flexible hose and wand. Use in same manner as upright machine. Various attachments are used for edging baseboards and furniture and to dust.

Wet-dry vacuum—This machine is normally used as a wet vacuum. If it is used as a dry vacuum, the dust filter must be put into the vacuum tank. Machine is then used in same way as an upright or tank-type.

If machine is to be used to pick up water, remove flexible hose, wand and electric cord from tank. Latch motor unit to tank, assemble flexible hose and wand, and plug cord into 110-volt outlet. Turn switch to **ON** position.

Place wand into water, slightly tipped forward and slowly pull wand toward you. (See *Figure 9-10.*) Repeat this movement until water has been picked up or until machine shuts off, which indicates the tank is full of water. If this is the case, remove vacuum motor top from tank to a service

Figure 9-10—To pick up water with a wet-dry vacuum, place the wand in the water and pull it toward you.

sink. If possible, get help to dump the water. Some models pump water from the tank.

Storage

Always empty and clean the vacuum before storing it. Electric cord, flexible hose and attachments should be kept with the machine in an orderly manner. Entire unit is then stored in a locked custodial storage room.

5-3 PERIODIC CARPET CARE

Also see Procedure 5-1

Job Description

In addition to daily or regular vacuuming (see Procedure 5-2), periodic surface cleaning and deep extraction of soil from carpets is necessary to prolong carpet life. After cleaning, carpets may be treated with an anti-static material to reduce static electricity.

Precautions

- Use all equipment according to manufacturer's recommendation.
- Use extra caution when using electrical cords on wet surfaces.
- Most carpet cleaning procedures can damage carpets if improperly used. If there is any question about whether a product is compatible with carpeting, test in an out-of-the-way corner.

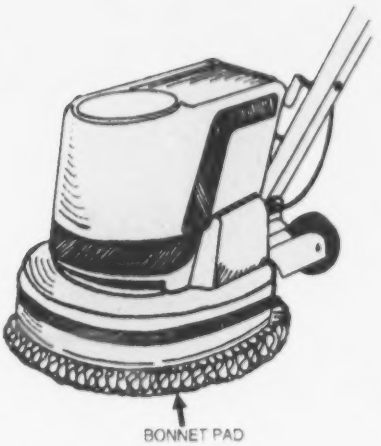


Figure 9-11—A rotary floor machine equipped with a bonnet pad is an effective way to remove oily surface soils from carpeting with shampoo or chemical pre-spray.

Time Guideline

- Varies widely. Managers should develop time standards.

Equipment

- Varies, depending on procedure.

Bonnet Cleaning Procedures

- Wet bonnet pad with cleaning solution or spray directly on small area of carpet.
- Use low speed rotary floor machine to work

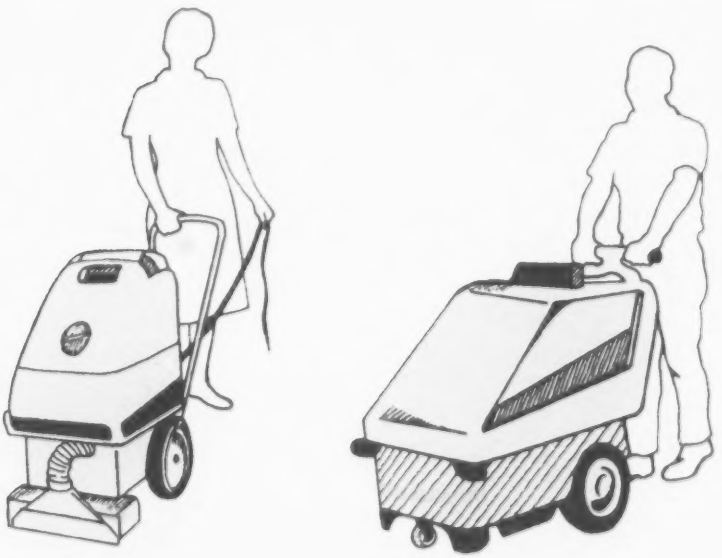


Figure 9-12—Self-contained machines for surface extraction include pulse shampooer (left) for quick cleaning in obstructed areas and the walk-behind automatic carpet shampooer. Various types of fans are available to reduce drying time.

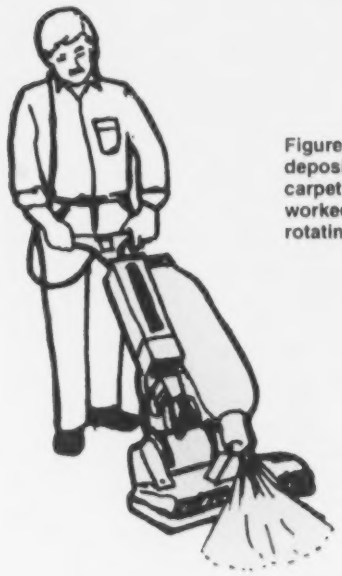


Figure 9-13—Mist sprayer deposits dry foam on carpet surface, where it is worked into the pile by a rotating brush.

pad over the carpet in tight, overlapping circles. (See *Figure 9-11.*)

• Clean bonnet pad with clear water or change pad as necessary.

Surface Extraction Procedures

• Use portable, self-contained extractor to spray cleaning solution, work with rotating brush, and lift out soil through vacuum head. (See *Figure 9-12.*)

• Allow sufficient drying time.

Dry Foam Procedures

• Using a dry foam machine, spray foam onto surface of carpet and work into surface. (See *Figure 9-13.*)

• Allow foam to absorb soil, according to manufacturer's instructions.

• Remove foam and soil with vacuum cleaner.

• Depending on humidity conditions, allow one to two hours before area can be open to traffic.

Detergent Solution Procedures

• A floor machine is used to feed detergent solution through a rotating brush onto the carpet. (See *Figure 9-14.*)

• Remove cleaning solution and soil with wet pickup vacuum. It is important to pick up suspended soil promptly before it can resettle into the carpet.

• Water/steam extraction machine drives cleaning solution into carpet pile under pressure, then extracts solution and soil in one step. (See *Figure 9-15.*) Follow manufacturer's instructions.

• Allow time for carpet to dry thoroughly before use.

Figure 9-14—For detergent cleaning, a floor machine with a liquid dispenser feeds detergent through the rotating brush.

Figure 9-15—A water/steam extraction machine cleans in one step.

Dry Cleaning Procedures

- To restore worn carpeting, sprinkle organic dry cleaning compound onto carpet and work into the pile, using a rotary brush machine.
- Allow compound to absorb soil according to product directions.
- Remove compound and soil with vacuum cleaner.

Storage

All carpet cleaning equipment should be thoroughly clean and dry before being stored in secure storage room.

6-1 FLOORS—UNCARPETED

Floor maintenance includes thorough cleaning and, when necessary, stripping, sealing, refinishing and buffing. These procedures may be assigned to the custodian in charge of cleaning the particular area or to a two-member custodial crew. Procedures are performed as needed, depending on type of floor, its condition and use of the area. The following information is intended to help custodial workers and supervisors develop their own school guidelines. The chart on page 64 lists procedures to be used on various types of floors—wood, resilient, and hard—in good, fair, poor and extreme conditions. The numbers in parentheses refer to detailed instructions on performing the procedures found in Sections 6-2 through 6-7.

The chart does not include floors made of PVC vinyl, urethane, or other similar chemical compounds. The maintenance team should develop procedures for treating such floors in accordance with each manufacturer's recommendations.

Time Guideline

Will vary widely according to procedures used, condition of floor, obstructions and other factors. Develop local guidelines using times given for specific job procedures, modified through experience. A balance should be reached between appearance of the floor and time spent on work.

General Procedures

- Observe condition of finish and floor covering. Unless specific instructions have been received, decide on cleaning and finishing methods to be used.
- Have proper supplies and equipment on hand before beginning work.
- Water should be used very sparingly on sealed wood floors and never on unsealed wood floors.
- Resilient floors should not be exposed to large amounts of water for extended periods.
- All work should be recorded on the Floor Maintenance Daily Work Report Card (see the Management Tools Appendix). Any work requiring extra time also should be noted on the daily card.

6-2 SWEEPING

Also see Procedure 6-1.

Job Description

Push brooms are used to remove dry bulky soil which is not easily removed by dust mopping. Floors also should be swept before dusting or wet mopping.

Time Guidelines

Unobstructed area: 10 minutes per 1,000 square feet.

Moderately obstructed area: 15 minutes per 1,000 square feet.

Heavily obstructed area: 20 minutes per 1,000 square feet.

Precautions

- Be careful to avoid striking people or objects with broom handle.
- Check wooden handles for splinters before using.

Equipment

- Push broom of appropriate width
- Counter brush or toy broom
- Dust pan, dust pan with long handle
- Putty knife

Procedure

- Use putty knife to loosen gum or other sticky substances.
- Size up the area and select a starting point.
- Grasp broom handle with left hand about half way down the handle. Right hand should be near the end of the handle. (If left-handed, use opposite positions.) See *Figure 9-16.*
- Keep feet about 12 inches apart and start with brush near feet.
- Push soil away a reasonable distance, four to

PROCEDURES FOR PERIODIC CARE OF UNCARPETED FLOORS*
(numbers in parentheses refer to more detailed explanations in Sections 6-2 through 6-8)

Condition of Finish and/or Covering	Wood Floors	Resilient Floors (vinyl, rubber, asphalt, cork, tartan)	Hard Floors (concrete, terrazzo, marble, slate, quarry, tile)
GOOD Light soil No void areas where finish has worn away	Dust mop (6-3) Clean with finish (6-6)	Dust mop (6-3) Clean with finish (6-6)	Dust mop (6-3) Wet mop (6-4)
FAIR Moderate soil Few void areas	Dust mop (6-3) Dry clean or use appropriate compound with floor machine (6-6) As needed: finish (6-8)	Dust mop (6-3) Wet mop (6-4) or scrub with floor machien (6-6), depending on soil As needed: finish (6-7)	Dust mop (6-3) Wet mop (6-4) or scrub with floor machine (6-6), depending on soil As needed: finish (6-7)
POOR Heavy soil Numerous void areas	Dust mop (6-3) Renovate (6-6) As needed: finish and/or seal (6-8)	Dust mop (6-3) **Scrub with floor machine (6-6) or power scrubber (6-5) As needed: seal and/or finish (6-7)	Dust mop (6-3) **Scrub with floor machine (6-6) or power scrubber (6-5) Seal (6-7)
EXTREMELY POOR Heavy soil Numerous void areas Surface appears porous or buildup of finish is evident	Dust mop (6-3) Renovate (6-6) Seal (6-8) As needed: finish (6-8)	Dust mop (6-3) **Scrub with floor machine (6-6) or power scrubber (6-5) As needed: seal and/or finish (6-7)	Dust mop (6-3) **Scrub with floor machine (6-6) or power scrubber (6-5) Seal (6-7) As needed: finish (6-7)

*This table does not include floors made of PVC vinyl, urethane, or similar chemical compounds. Because of variations among such products, it is essential to base maintenance procedures on each manufacturer's recommendations. For asbestos flooring, consult the Asbestos Management Plan for your building or your state's regulatory agency.

**For heavy soil, a power scrubber may be used in large, open areas. A floor machine is used in small or obstructed areas.

Figure 9-16—In sweeping, cover as much area as possible with each stroke, but do not stretch arms.

five feet. Cover as much area as possible with each stroke, but do not stretch arms.

- Push broom with top hand and allow handle to pass through other hand.
- Shift weight from foot to foot as you push brush forward and return it.
- It may be helpful to tap the brush at the end of the stroke so soil drops out of fibers.
- Develop a natural pattern and rhythm to sweeping.
- Use a toy broom or counter brush to clean hard-to-reach areas.
- Move soil into a pile and use brush to push into dust pan.

Storage

- Clean out bristles with brush comb after work and hang broom or brush so bristles hang free. See *Figure 9-17.*

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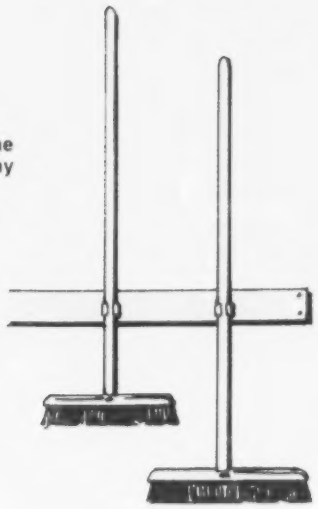


Figure 9-17—Hang a broom or brush so the bristles are free of any weight.

• If the handle is movable, change its position once a month to prolong life of broom.

6-3 DRY (DUST) MOPPING

Also see Procedure 6-1.

Job Description

Dry mopping, or dust mopping, is a quick way to clean floors and, done properly, is effective. Often a cotton strand mop treated with a dust controllant is used; it effectively removes dry soil and dust from most types of floors, but a treated mop should not be used to clean wet floors.

Precautions

• When moving backward while mopping, be aware of possible hazards in your path.

• When mopping stairs, always feel for the next step with your foot before shifting weight.

• Keeping arms close to the body helps eliminate fatigue. See *Figure 9-18.*

• Never leave a mop standing or spread on a floor unattended for any length of time.

• Be alert at all times, especially in congested areas such as laboratories or on stairways.

• Always be aware of the position of the mop handle to avoid hitting furniture, equipment, walls or windows.

Time Guidelines

Unobstructed area: 7 minutes per 1,000 square feet.

Moderately obstructed area: 10 minutes per 1,000 square feet.

Heavily obstructed area: 20 minutes per 1,000 square feet.

Figure 9-18—In dust mopping, keep your arms close to your body to reduce fatigue. Keep the leading edge of the mop the same as you move around the room.

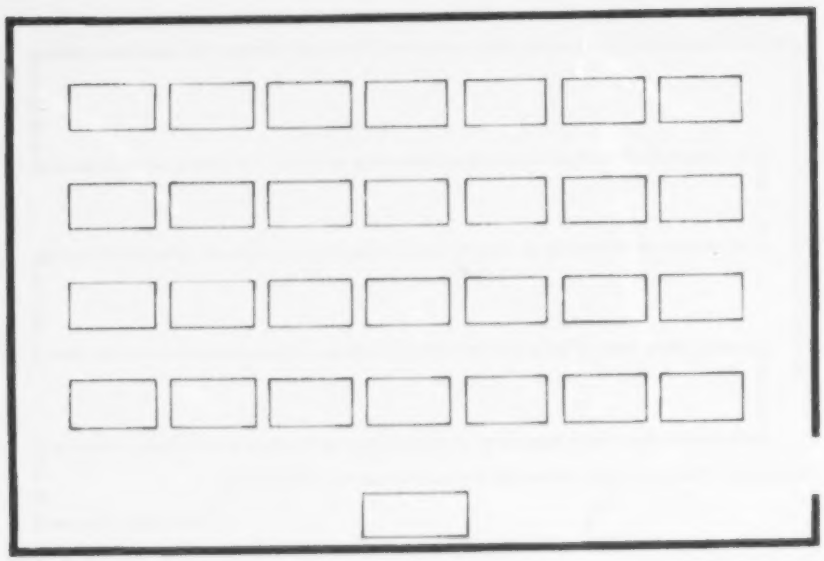


Figure 9-19—Dry mopping pattern must be adapted to room and equipment layout. Pattern illustrated here is suitable for most traditional classrooms.

Equipment

- Dust mop
- Wedge dust mop

Procedures

- Dust mops may be used to remove litter, soil and dust from most kinds of floors.
- Use mop after dusting furniture and equipment so that dust brushed to the floor will be removed.
- Pattern of mopping will vary depending on the area. Generally, the movement is in a clockwise or counter-clockwise pattern, pushing the dirt to the main aisle for pickup. See *Figure 9-19.*
- Mop closely around legs of equipment, baseboards, corners and behind open doors. Avoid doubling back, which wastes time.
- Lay mop head flat on the floor and make sure the leading edge of the mop stays the same as you move around the room. Move right to left if right-handed or left to right if left-handed.
- When mopping under a desk or table, hold the mop handle close to your right side, and mop head close to your feet. Move chair away from desk with your left hand. See *Figure 9-20.* Bending slightly at the waist, mop under the desk from right to left, returning mop to starting position. Replace chair under desk.
- When approaching corners, with a twist of the wrist, let one end of the mop move into the corner, and proceed at a 90 degree angle along the baseboard.
- In open areas, such as large rooms or hallways, push the mop ahead with top end of mop handle held about chest high.
- To mop steps, back down the center of the stairs, mopping the third step above you. Start at the middle and cover both halves of the step by twisting the wrist. Feel for the next step down with right food before putting weight on this foot. Be sure to locate the last step before shifting weight. Also see suggestions in *Figures 9-21* and *9-22.*
- Do not raise the mop off the floor until it is full of dust and soil. Then, in an open, unmopped

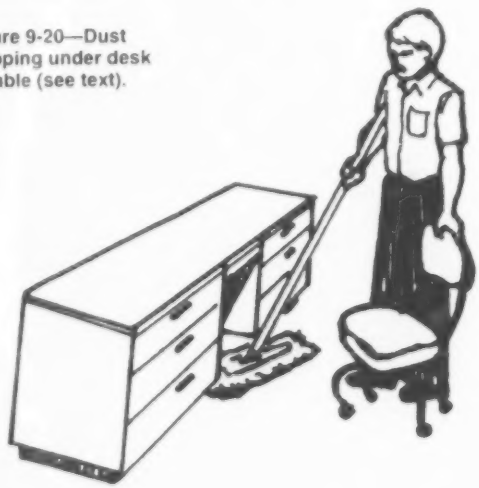


Figure 9-20—Dust mopping under desk or table (see text).

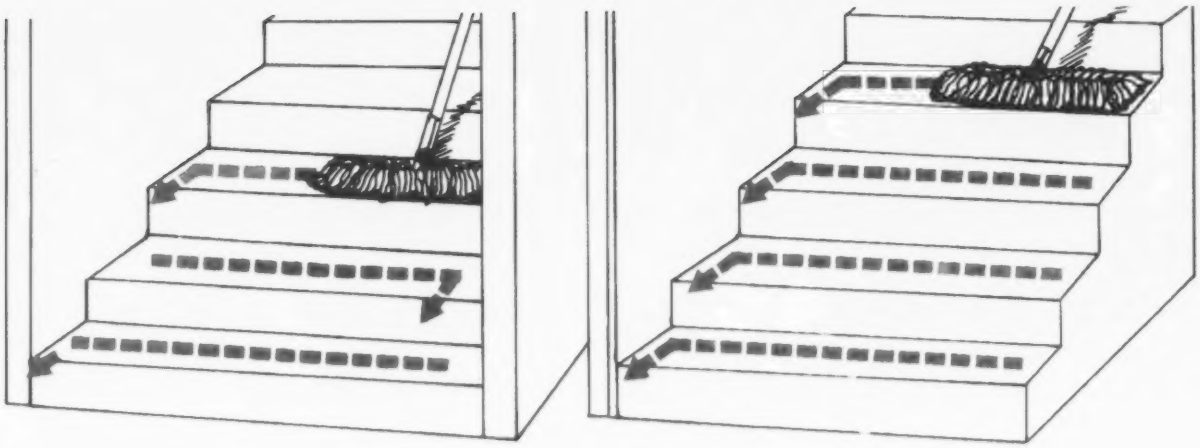


Figure 9-21—For best results on enclosed stairs (left) dry mop in alternate directions. On partially open stairs (right) mop only in one direction—toward the enclosed side.

area, raise the mop from the floor about 12 inches, hold one hand one-third of the length from the mophead, and the other hand two-thirds of the length from the mophead, and shake dust and soil from the mop. Keep mophead low to avoid scattering dust into the air.

• Use the mop to move soil into a small pile that can be picked up with a dust pan and counter brush. Always pick up the dirt after shaking the mop. Remop the area after dirt is picked up. Never shake the mop outside the building onto the ground.

Storage and Treatment of Mophead

• Initial treatment: Use about eight ounces of dust controllant to treat a new wing mophead. Apply controllant on dusting side of head to center of strands. Fold mophead over onto itself, then allow it to set for about one week.

• Retreatment: Periodic retreatment of the mophead should be done in the same way as the original treatment, except that only four ounces of controllant should be used. Retreat the mophead at the end of the workshift and preferably on the last workday of the week, to allow time for the treatment to penetrate.

• To store the mophead, shake the mop as described under "Procedures" and store (in a metal mop pan) in a locked custodial storage room. Lay the head flat on the bottom of the pan.

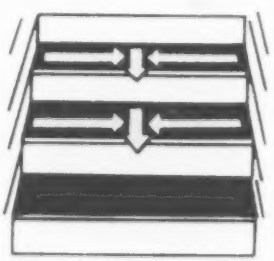


Figure 9-22—On stairs that are open on both sides, mop toward the center of the stairs and then down.

6-4 WET MOPPING

Also see Procedure 6-1.

Job Description

Wet mopping is used to loosen and remove soil from floors in areas that cannot be adequately cleaned with the dry mop, such as restroom floors, entrances, around vending machines, cafeterias, and so forth.

Precautions

• Be careful when walking on a wet floor.

• Control traffic in the area while the floor is wet.

• Be careful in raising the mop handle when wringing mophead.

Time Guidelines

Unobstructed area: 30 minutes per 1,000 square feet.

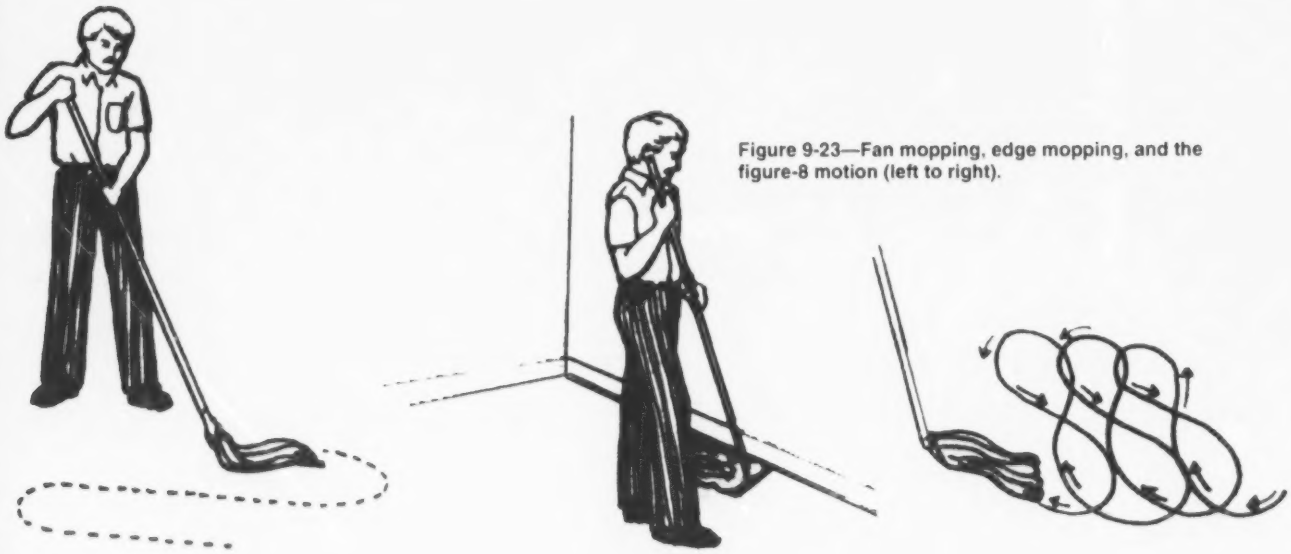


Figure 9-23—Fan mopping, edge mopping, and the figure-8 motion (left to right).

Moderately obstructed area: 40 minutes per 1,000 square feet.

Heavily obstructed area: 55 minutes per 1,000 square feet.

Equipment

- Cleaning solution
- Mop handle
- Cotton mophead
- Gear press mop unit

Procedure

- Mix all-purpose cleaner and water in solution according to manufacturer's directions.
- Sweep or dust mop the area to remove debris.
- For hard-surface floors, dip mophead in bucket and squeeze excess solution from mop with wringer. Leave mop wet enough to wet floor thoroughly.
- Fan mop and edge floor along baseboard to far end of room. When fanning mop, be careful not to splatter walls, baseboards, or fixtures. Wipe up any splatters immediately with cheesecloth or similar clean cloth. See *Figure 9-23*.
- Using a figure-8 motion, cover entire area with solution. If necessary, re-wet mop in bucket.
- After entire area is covered, dip mophead in solution. Put mophead in wringer, holding mop handle with left hand and wringer handle with right hand, stand slightly to the left of center of the bucket and flex knees to put weight onto wringer handle. Keep back straight at all times.
- Change cleaning solution as soon as it becomes dirty to prevent a streaky floor. Turn mophead periodically.
- Cover floor again as above, using figure-8 pattern, and leave floor as dry as possible.
- Because excess water can damage some soft-surface floors, it may be necessary to use only the drying, or second step of the procedure, to control the amount of water on the floor.

Storage

- Rinse mophead thoroughly and spread it out on mop rack or over bucket to allow it to dry. See *Figure 9-24*.
- Thoroughly rinse and dry mop bucket and wringer. Periodically apply a few drops of oil to castors.
- Entire unit should be stored in locked custodial storage room.

6-5 AUTO SCRUBBING

Also see Procedure 6-1

Job Description

Scrubbing and cleaning a large open area using an automatic scrubber. (See *Figure 10-28* in Chapter 10.)

Safety Precautions

- Charge battery in a well-ventilated area.
- Be sure battery terminals are connected cor-

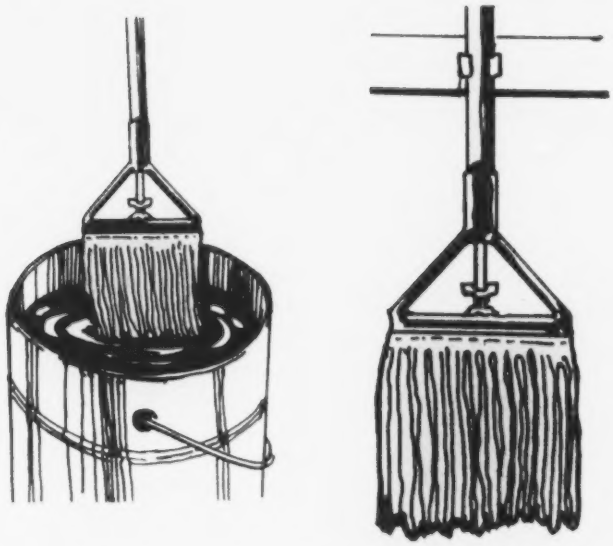


Figure 9-24—Thoroughly rinse the wet mop and hang it in a well-ventilated storage room.

rectly.

- Connect charger before turning it on.
- Be aware of locations of electrical outlets and avoid them when the area is wet.
- Be careful not to run scrubber into walls or furniture which could cause damage.
- When removing tanks from scrubber, use correct lifting techniques.
- Consult the designated person for dealing with asbestos in your district before scrubbing vinyl asbestos tile. Some high speed abrasive scrubbing procedures can release asbestos fibers, but wet scrubbing with low abrasion pads at low speeds may reduce this problem.

Time Guidelines

Unobstructed area: 15 minutes per 1,000 square feet.

Average obstructed area: 30 minutes per 1,000 square feet.

Setup and cleanup time make it uneconomical to do less than one to two hours of automatic power scrubbing at a time.

Equipment

- Battery-powered, self-propelled automatic scrubber with portable battery charger.

Procedure

- Take machine and proper cleaning solution tank to work area.
- Follow the manufacturer's directions for turning on power and water solution controls.
- Start machine moving and, following manufacturer's directions, lower scrub brushes and squeegee until they make contact with the floor.
- Guide the machine across the floor. Near the end of the area being cleaned, pivot the machine and clean the next strip of floor, overlapping the previously scrubbed area.
- Shut off solution about 10 feet before reaching the end of the area being cleaned.
- Raise brushes to clear floor before stopping the machine.
- Keep squeegee lowered until all solution has been picked up, then raise squeegee.

Cleaning and Storage

Before storing the automatic scrubber:

- Empty tanks and flush with water.
- Check filter and clean with water.
- Clean battery connections with a mild solution of ammonia and water or soda and water.
- Wash all exterior parts of the machine with a mild solution of all-purpose cleaner and water.
- Wipe bottom edge of squeegee with a piece of cheesecloth. Leave squeegee in UP position.
- Check and rinse hoses periodically.
- Check gearbox and chains once a month. Notify supervisor when they need lubrication.

6-6 FLOOR MACHINE PROCEDURES

Also see Procedure 6-1

Job Description

Floor machines may be used to clean small or obstructed areas that will not permit use of an automatic scrubber.

Precautions

Consult the designated person for dealing with asbestos in your district before scrubbing vinyl asbestos tile. Some high speed abrasive scrubbing procedures can release asbestos fibers, but wet scrubbing with low abrasion pads at low speeds may reduce this problem.

Time Guidelines

See Automatic Scrubbing, Procedure 6-5.

Equipment

- Either a rotary type floor machine which rotates at about 175 rpm or a high-speed machine rotating at about 1,100 rpm.
- Brushes, abrasive pads, or steel wool pads, depending upon cleaning action required and manufacturer's instructions.
- All-purpose cleaner or stripping compound.*
- Wet-dry vacuum or mop and tank.

Procedure for Routine Scrub

- Dry mop if necessary to remove loose dirt and dust from the floor.
- Use a water mop to wet down a small area in front of the floor machine with solution of all-purpose cleaner or wax stripper.*
- Leave cleaning solution on floor less than a minute.
- Use a putty knife to remove gum or other material, but be careful not to damage floor covering.
- Scrub with abrasive pad or scrub brush, depending on condition of floor, following manufacturer's instructions. See *Figure 9-25.*
- Pick up water with wet-dry vacuum or wet mop.
- Rinse floor with clear water and pick up rinse water.
- Remove water as soon as possible from soft floors. Do not let water run under furniture or file cabinets.

Other Procedures for Floor Machine

Dry cleaning: Either a fine grit abrasive pad, a buffing brush or a steel wool pad may be used with a floor machine for dry cleaning. The action of the high-speed machine loosens surface particles, which are then picked up with a dust mop.

*Consult your school's designated asbestos manager before applying stripper to flooring that may contain asbestos.

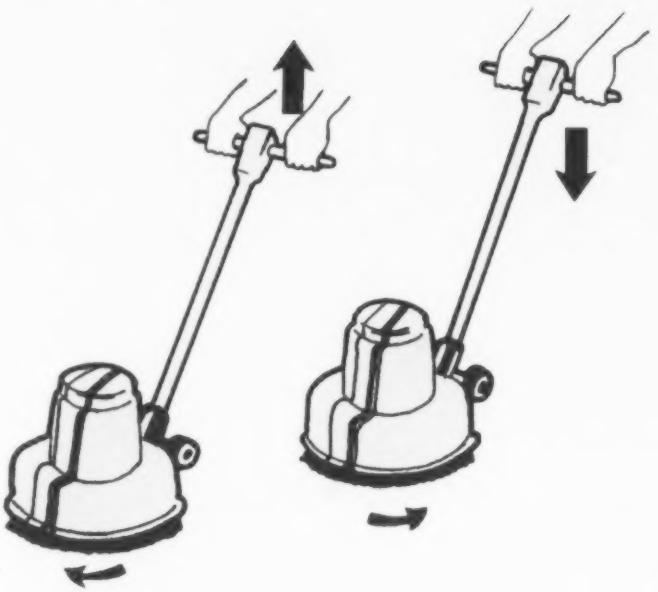


Figure 9-25—A floor machine is used for wet scrubbing. Raise handle to move machine right; lower handle to move left.

Cleaning with finish: The procedure is basically the same as the method described for dry cleaning. Use floor finish, usually in a 1:1 dilution with water, instead of all-purpose cleaner or wax stripper. Do not rinse.

6-7 SEALING AND REFINISHING FLOORS

Also see Procedure 6-1

Job Description

Sealing and refinishing of floors may be performed by the custodian in charge of cleaning the area or by a two-person custodial crew. The work is performed as needed. Normally, floors are refinished for one of the following three reasons, in order of importance: to protect the surface from wear, to facilitate daily maintenance, and to enhance appearance. Such factors as durability, water resistance and ease of application are of

primary importance in selecting floor products. Appearance is important, but secondary.

Time Guidelines

Unobstructed area: 60 minutes per 1,000 square feet.

Moderately obstructed area: 120 minutes per 1,000 square feet.

Heavily obstructed area: 180 minutes per 1,000 square feet.

Equipment

Depends upon method of cleaning and refinishing selected.

Procedure

- Decide on method of cleaning and refinishing, depending on type of floor and condition of finish. For guidance, see the chart on page 64.
- Thoroughly clean floor, using appropriate method (Procedures 6-2 through 6-6).
- Floors should be stripped of all finish only in isolated instances, and only in consultation with the supervisor. Normally floors are stripped only if there is a change in products to be used or if the floor has been improperly maintained.
- Seal floor if necessary (see below).
- Allow floor to dry and apply one coat of finish according to manufacturer's instructions. Finish may be applied with a long strand mophead or with a special tool supplied by the manufacturer.
- Use the standard figure-8 mopping pattern. Be sure to overlap strokes for even coverage. Take care to avoid streaking.
- Always spread a thin coat of finish.
- The first coat should not be applied closer than 12 inches from the baseboard, unless the floor has been stripped.
- Let the first coat of finish dry thoroughly.
- If two coats are needed, apply second coat, working up to baseboards.
- Let second coat dry thoroughly.
- Clean any spattered baseboards or furniture.

General Instructions

- The most efficient work pattern will vary among different areas. Study the area to determine the most efficient pattern.
- During periods when other work cannot be done (for example, while finish is drying), clean abrasive pads and other equipment and/or prepare other areas for floor work.
- Rotate various jobs so each crew member shares in the work.

6-8 REFINISHING WOOD FLOORS (GYMNASIUMS)

Also see Procedure 6-1.

Job Description

Gymnasium floors should be dust mopped at least twice on days when school activities are going on. The amount of periodic care needed depends on the amount of use for school and outside activities.

Choosing a Seal and Finish

Hillyard, Inc., of St. Joseph, Missouri, recommends the following:

- When selecting a wood seal and finish, choose compatible products manufactured by the same company. Most companies sell compatible products as a team.
- There are several categories of products available. Originally, phenolic or tong oil materials were used, and these are still available. Next came oil-modified epoxies, then oil-modified urethane products. The newest is a water-borne epoxy. Moisture cured urethanes are not recommended because they may be toxic during application and slippery. When choosing a solvent-based product, the buyer should look for a wood seal of about 28 to 30 percent solid content (NVM), and the gymnasium finish should be about 40 percent solids.
- Be careful to purchase a high-grade solvent for the cleaning process. Avoid solvents that are high in oil content, as they leave an oily film on the floor, which causes seals and finishes to peel.

Procedure

- At least one two-worker crew should be used for every 5,000 square feet of floor.
- After the floor has been sanded, check for sanding marks by wiping certain areas with a towel soaked with high grade solvent. Examine areas to see whether sanding marks are visible.
- Vacuum the floor after sanding. Also vacuum sawdust from window sills, bleachers, stages and other horizontal surfaces.
- Tack rag the floor three times or more, using a towel wrung out in the high grade solvent. Use

a push broom to "mop" the floor with the towel until the floor is clean.

- Apply the first coat of seal using a 12-inch lambs wool applicator, applying the seal **across** the grain in a four-foot-wide strip across the floor.
- A second worker, with a dry applicator, should follow about 10 feet behind and pull the seal out with the grain. Enough people should work on a team so that the edge is always wet.
- After the first coat of seal has been applied, allow the floor to dry overnight (at least 12 hours).
- Depending upon the seal product, it may be necessary to go over the entire floor with #2 steel wool and again tack rag once or twice to pick up dust and steel wool particles.
- Apply the second coat of seal the same as the first, and allow to dry overnight.
- If necessary, go over the coat with #2 steel wool and tack rag the floor.
- Lay out and paint game markings in accordance with interscholastic standards.
- If paint lines dry more than 24 hours before recoating, all lines must be steel wooled.
- Tack rag floor again and apply a coat of finish in the same way that the seal was applied. Allow to dry overnight, go over with steel wool, tack rag, and apply final coat of finish.
- Keep everyone off the floor for a minimum of three days, and preferably seven days to allow finish to cure properly.
- Dust mop floor before use.

7 GLASS, INTERIOR

Job Description

Cleaning entrance and partition glass, mirrors, glass desk tops.

Precautions

- Do not spray window cleaner toward you. Protect your eyes.
- Be sure there are no splinters on wooden doors.
- Do not over-reach to reach the tops of doors or partition glass.
- Make sure there are no cracks in mirrors and desk top glass.
- Do not stand on furniture or equipment or above the third step from the top of a stepladder.

Time Guidelines

- 1/4 to 1 minute per unit.

Equipment

- Cheesecloth or cloth pads
- Bucket
- Squeegee
- Sponge
- Spray bottle (manual)

Procedure

- In general, apply a small amount of cleaner to glass using a vertical spraying motion.

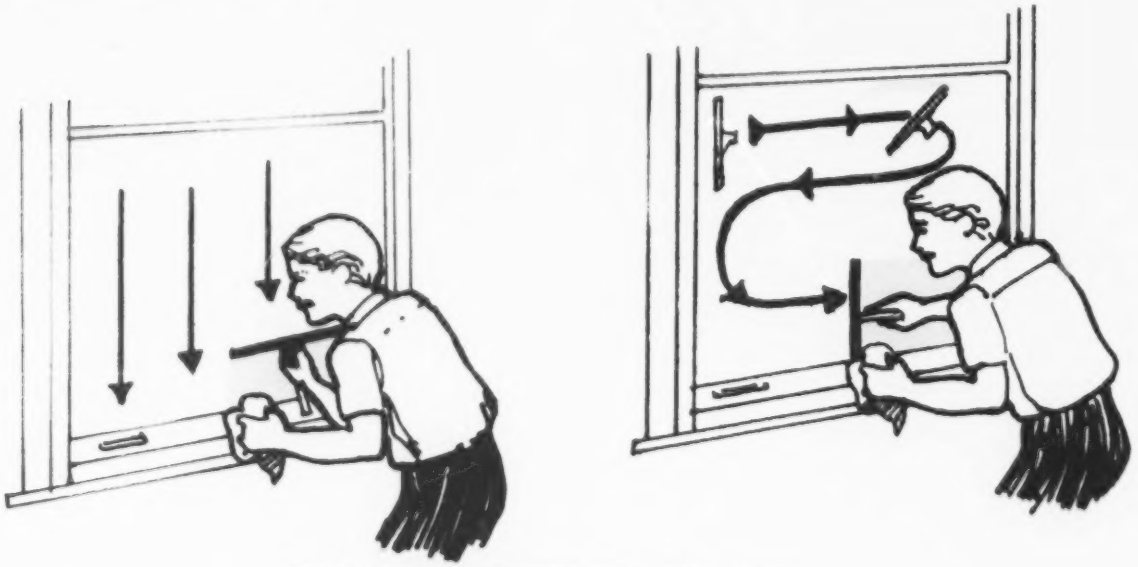


Figure 9-26—Efficient squeegee motions make water run toward trailing edge and away from the cleaned area.

Figure 9-27—Using spray bottle method, use cheesecloth pad to wipe dry.

- Use cloth pad to spread cleaner.
- Rub glass with cloth pad or paper towel until cleaner dries.
- Avoid using too much glass cleaner; it will be hard to remove.

Door Glass and Partition Glass

- Use squeegee and water method. Wash glass with sponge and water. With either horizontal or vertical overlapping strokes, wash the entire surface
- Use a stepladder to clean upper glass first.
- One of two squeegee motions can be used to remove water from glass. If side-to-side strokes are used, start with the squeegee in a vertical position at an upper corner of the window and stroke across the pane to the opposite side, then make a simple half turn and return. Use one continuous back-and-forth overlapping stroke, as shown in *Figure 9-26.*
- If vertical strokes are used, start in upper corner and draw the squeegee to the bottom of the pane in separate overlapping strokes.
- After each stroke, wipe the blade of the squeegee with a sponge.
- When the job is finished, wipe up any excess water with a sponge.

Mirrors, Glass Top Desks and Spot Washing Door Glass

- Use spray bottle method: Spray glass with window cleaner, then wipe dry with a pad of cheesecloth. (See *Figure 9-27.*)
- On stubborn spots, a second application of window cleaner may be necessary.

Storage

- Empty and dry bucket.
- Refill spray bottle.
- Rinse and ring dry cheesecloth and sponge. Hang up cheesecloth to dry.
- Store all materials and tools in locked storage room.

8 LIGHT BULB REPLACEMENT

Job Description

Incandescent and fluorescent light bulbs or tubes normally are replaced when burned out. However, in hard to reach areas, bulbs or tubes may be replaced on a predetermined schedule or after a certain number have burned out. Mass replacement usually is done by a crew using special ladders.

Precautions

- Be sure electricity is turned off during bulb or tube replacement work. Turn back on only after work is complete.
- Use bulbs or tubes of the same wattage as those being replaced.
- Carefully clean up any broken glass.
- Use stepladder carefully.
- If there is any question about a job, see your supervisor before beginning work.

Figure 9-28—Ladders, scaffolding and a screwdriver are among the equipment used to replace light bulbs.

Time Guidelines

- 1/2 to 7 minutes per bulb or tube.

Equipment

- Stepladder or scaffolding (see *Figure 9-28*)
- Duster
- Replacement bulbs or tubes
- Screw driver
- Special bulb replacement tool (see *Figure 10-23* in Chapter 10)

Procedure

- Check to make sure the problem is just a burned out bulb and not trouble in the wiring. Check with supervisor if there is any question.
- Turn off electricity.
- Set up stepladder or scaffolding. Check for safety.
- Open light fixture or remove globe and put it in safe place. Clean before reassembling fixture.
- Never use a replacement bulb or tube with a higher wattage unless it has been approved by your supervisor.
- Replace tube or bulb and discard burned out one in appropriate trash container.
- Complete replacement record.
- Turn electricity back on; check to see that light works.
- If necessary report repairs on a "repair needed" form (see *Figure 8-1* in Chapter 8).

9 LIGHT FIXTURE CLEANING

Job Description

Regular cleaning of light fixtures maintains maximum lighting efficiency.

Precautions

- Turn off light switch before doing any cleaning.
- Clean light fixtures only when there are few people using the area.
- Never touch hot light bulbs with wet hands.
- Use ladder or scaffolding safely.
- Clean fixtures in a safe place where they will not be damaged.
- Remove movable equipment and furniture if necessary.
- Use rubber gloves to protect the hands.

Time Guidelines

- 5 to 10 minutes per light fixture.

Equipment

- Two plastic pails
- Ladder or scaffolding (see *Figure 9-28*)
- Sponges
- Rubber gloves
- Cheesecloth or cloth pads
- Cleaning solution
- Treated duster
- Tank vacuum cleaner and attachments

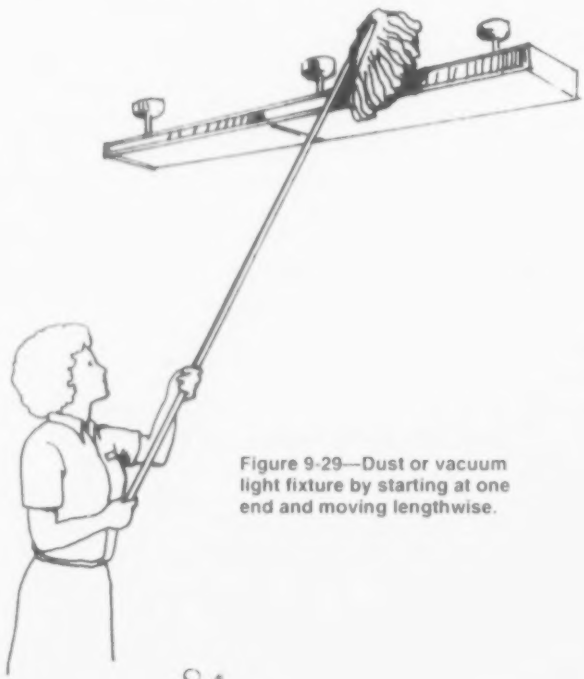


Figure 9-29—Dust or vacuum light fixture by starting at one end and moving lengthwise.

Procedure

- Move equipment to room or area where fixtures are to be cleaned. Make certain the lights to be cleaned are turned off.
- Be careful to avoid soiling floor or ceiling.

Dry Fluorescent Light Fixture Cleaning

- Select a starting point and dust or vacuum each fixture, starting at one end and moving the duster or vacuum lengthwise. (See *Figure 9-29.*)

Wet Fluorescent Light Fixture Cleaning

- Fill one plastic pail with clear warm water and the other pail with warm water and cleaner.
- Use a separate sponge in each bucket.
- Place ladder and two buckets in safe position for working.
- Remove loose soil with treated duster or damp sponge.
- Open fixture, carefully remove fluorescent tubes, and put them in a safe place.
- Remove egg-crated type grid.
- With wash sponge, clean fixture inside and out.
- Wipe with rinse sponge. Allow to air dry or wipe dry with clean dry cloth.
- Wipe fluorescent tubes with damp cloth and replace in fixture.
- Replace clean egg-crate grid.
- Check work. Fixture should be free of all dirt.

Dry Incandescent Light Fixture Cleaning

- Be sure light is turned off.
- Remove globe and clean inside and out with a damp cloth.
- Replace clean dry globe.

Wet Incandescent Light Fixture Cleaning

- Be sure light is turned off.
- Remove globe and wash inside and out with sponge and cleaning solution.
- Rinse globe using clean sponge.
- Allow globe to air dry or use a clean dry cloth to wipe it dry.
- Replace clean globe on light fixture.
- Be sure to replace wash and rinse water when necessary.

10 MOVING

Job Description

School custodians often are called upon to move supplies, equipment or furniture.

Precautions

- Always use proper procedures for lifting and use appropriate safety equipment.
- Be careful in maneuvering large objects to avoid damage to doors, walls or other furniture or equipment.

Time Guideline

- No estimates available; depends on situation.

Equipment

- 2-wheeled truck (see *Figure 9-30*)
- 4-wheeled truck
- Desk dollie (see *Figure 9-31*)

Procedure

- Walk from starting point and point of final destination to find the shortest and easiest route available.
- Prepare both areas and the route between by moving anything that will interfere with the move.
- Assemble moving equipment and take it to the starting point.
- Check size and weight of each load and select an appropriate piece of equipment.
- Be careful to use equipment as recommended and to use correct lifting procedures in lifting heavy furniture and equipment. (See *Figure 9-32.*)

Storage

After each use, clean equipment, inspect for damage and store in locked storage area.

Figure 9-30—Two-wheeled truck and four-wheeled truck.

Figure 9-31—A desk dolly (left) and how it works.

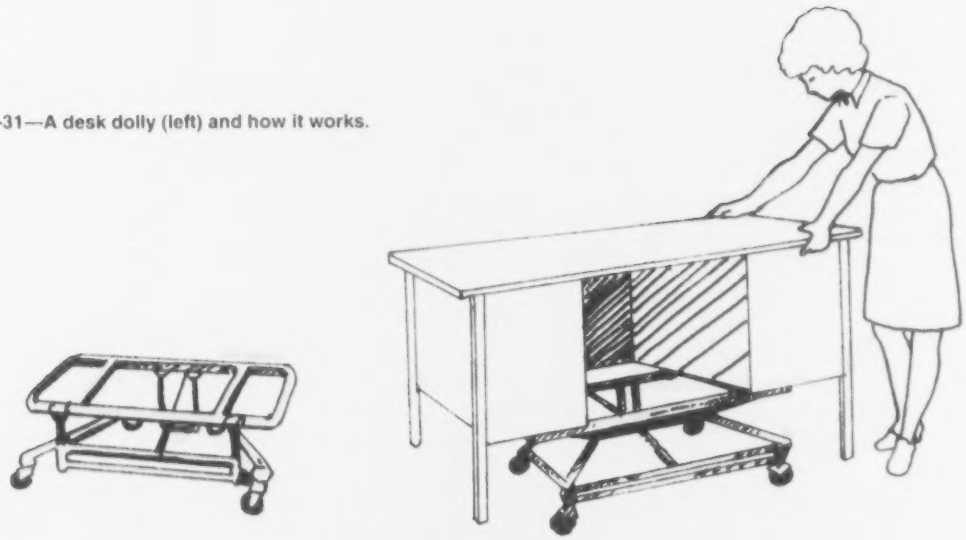


Figure 9-32—Select the right piece of equipment for each moving job and use it correctly to avoid injury and property damage.

11 PLUMBING FIXTURE CLEANING

Job Description

Plumbing fixtures must be cleaned inside and out daily. A pattern of cleaning restroom fixtures and water fountains should be established to eliminate doubling back and ensure that all fixtures are cleaned daily.

Precautions

- Do not use the same cloth that has been used on urinals and stools to wash basins.
- Do not use abrasive cleansers for routine cleaning. For stubborn stains, use cleansers approved for vitreous china or stainless steel.
- Be sure not to spray cleaning solution into eyes.
- Since water and cleaner will be splattered onto floor, be careful in moving around room.
- Be aware that people may be using the room while it is being cleaned.
- If stronger than normal cleaners are needed due to water conditions or special circumstances, use as directed by manufacturer.
- Use acid cleaners with special care.
- Review the section on Bloodborne Pathogens in Chapter 6.

Time Guideline

- Three minutes per fixture.

Equipment

- Acrilan swab (see *Figure 9-33*)
- Abrasive pad
- Appropriate cleaners—all-purpose (APC), disinfectant, germicidal
- Cheesecloth or cloth pad
- Rubber gloves

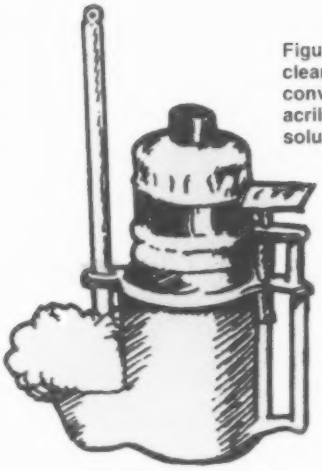


Figure 9-33—Toilet cleaning kit provides a convenient carriage for acrilan swab and cleaning solution.

- Sponge mop
- Glass cleaner

Procedure

- Clean all fixtures with a solution of cleaner and water. (Follow manufacturer's directions. Solution for cleaning fixtures should be approximately four times the strength used for mopping floors.) Allow solution to set for several days to ensure it is thoroughly mixed. A disinfectant may be desirable.

Wash Basin

- Wearing rubber gloves, spray cleaning solution over entire basin, including faucets. With abrasive pad, scour entire basin—inside, outside and underneath. Pay particular attention to areas around drain and base of faucets. (See *Figure 9-34.*)

Allow to air dry.

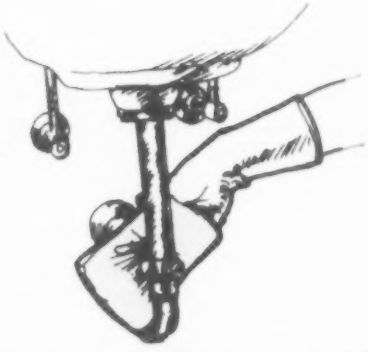


Figure 9-34—A relatively strong cleaning solution should be used on wash basins. Scour inside, outside, underneath, and faucet.

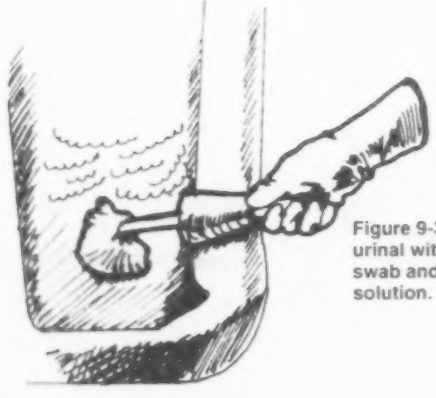


Figure 9-35—Clean urinal with acrilan swab and cleaning solution.

Urinals

- Put on rubber gloves.
- Flush urinal, then force water over trap in drain with acrilan swab.
- Spray cleaning solution over entire area of urinal and onto the swab.
- Scrub urinal inside and out, and down into the drain as far as possible, under rim at sides and top and underneath. (See *Figure 9-35.*)
- Let urinal air dry, then flush.

Stools

- Put on rubber gloves.
- Flush stool.
- Raise seat and force water over the trap with the acrilan swab.
- Spray entire stool area, including seat, with cleaning solution; scrub with acrilan swab. (See *Figure 9-36.*)

Figure 9-36—Spray the entire stool area with all-purpose cleaner, scrub with an acrilan swab, and dry the seat with a pad of cheesecloth.

- Pay particular attention to drain, under rims, and where seat attaches to stool.
- Dry both sides of seat with cloth pad and leave up to air dry. Flush stool.
- Spray cleaning solution onto pad of cheesecloth and clean splatters and graffiti from partitions, using abrasive pad if necessary.

Figure 9-37—If water fountain is stainless steel, use cloth to scrub rather than abrasive pad.

Service Sinks

- Clean service sinks with acrilan swab.
- Spray sink area and scrub inside and out with cleaning solution.
- Allow to air dry.

Shower Stalls

- Wear rubber gloves.
- Apply cleaning solution on walls and scour with abrasive pad to remove soap residue and body oils.
- Clean drain and floor area with acrilan swab or sponge mop.
- Make sure drain areas are free from hair, pieces of soap, and other debris.
- Dry walls with cheesecloth. Run water to rinse floor.

Water Fountain

- Apply cleaning solution over top areas of water fountain including faucets.
- Scrub top area with abrasive pad.
- If water fountain is stainless steel, use cloth to scrub instead of abrasive pad. (See *Figure 9-37.*)

Mirrors

- Spray glass cleaner on mirror and wipe dry with pad of cheesecloth or paper towel. (See *Figure 9-38.*)

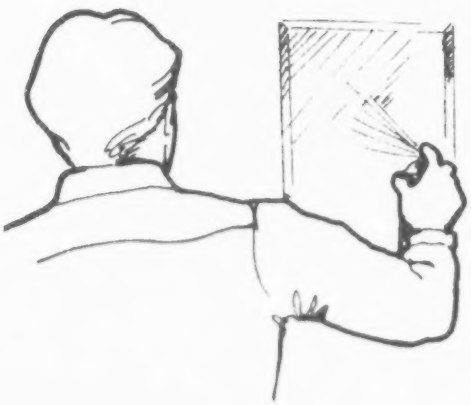


Figure 9-38—Clean mirrors with spray cleaner and cheesecloth or paper towel.

Storage

- Rinse and wring dry acrilan swab and abrasive pad; store on custodial cart.
- Rinse sponge mop and hang in custodial storage room.
- Rinse cloth at end of day and hang to dry. Dispose of worn-out cheesecloth.
- Store cleaning solution, glass cleaner and rubber gloves on custodial cart.

12 SNOW AND ICE REMOVAL

Job Description

Snow and ice removal usually take precedence over regular assigned duties. Usually snow and ice are removed from sidewalks, entrances, steps, porches and so forth at beginning and end of work shift. Steps to large trash containers and platforms also must be cleaned of snow and ice before being used.

Precautions

- Ice and snow should be removed at the beginning and end of shift, even if snow is still falling, to prevent accumulation.
- Be careful to use correct lifting procedure when shovelling snow or chipping ice.
- Remove ice and snow from steps and entrances to prevent melting and refreezing.

Time Guideline

- No estimate possible; varies widely.

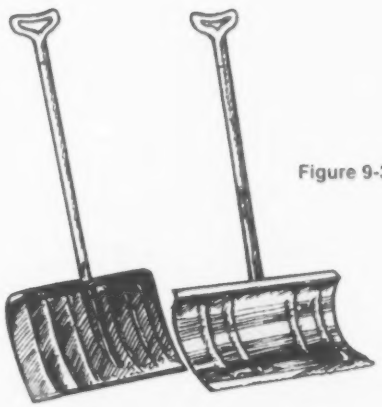


Figure 9-39—Snow shovels.

Equipment

- Snow shovel (see *Figure 9-39*)
- Ice chipper
- Push or straw broom
- Sand
- Ice melt
- Snow plow, broom
- Snow blower mounted to grass mowing machine

Procedure

- Procedure and equipment vary with the method used.

Snow Shovel

- Shovel should be inspected before use for damaged spots. Handle should be checked for cracks or splinters.
- Be sure to lift shovel in a way that keeps weight on your legs and not on your back.
- Be careful of breaks in walk or steps that might cause shovel to jar.
- Move snow and ice away from entrance and steps.

Ice Chipper

- Ice chipper is used to remove solidly frozen ice. It may be used in an up and down chopping or a pushing action.
- Use with caution to avoid injury or damage to concrete steps and entrance ways.

Push or Straw Broom

- Use to move light snow or snow between gratings.

Figure 9-40—Typical snow blower for clearing sidewalks.

Ice Melting Chemicals

- Chemicals should be used sparingly to remove ice from steps and entrance ways, as they are tracked into buildings, possibly damaging floor coverings.
- Chemicals should be applied only according to the manufacturer's directions on the label.
- Chemicals may lose effectiveness as temperature drops below 20 degrees.
- Chemicals should be stored in a moisture-proof container in locked storage room.

Sand

- Sand is spread on stubborn areas of ice for traction when ice melt is not effective.
- Sand, like chemicals, should be used sparingly, as it will be tracked into building.

Snow Blower

- The walk behind snow blower used according to manufacturer's recommendations effectively clears snow from walks. (See *Figure 9-40.*)
- Unit must be properly maintained, fueled and operated according to manufacturer's recommendations.

Care and Storage

All equipment should be cleaned and dried before storing in a locked storage room.

13 SOAP AND PAPER DISPENSERS

Job Description

Replenishing supplies and cleaning soap and paper dispensers.

Safety Precautions

- Watch for sharp edges on dispensers.

Frequency

- Clean dispensers daily. Replenish supplies when there is not enough to last until the next day.

Time Guideline

- 1/4 to 3 minutes per unit

Equipment

- Cloth pad
- Cleaning solution in spray bottle
- Liquid soap in squeeze bottle
- Roller and/or bifold paper towels
- Toilet tissue
- Soap dispenser
- Towel cabinet key

Paper Towels Procedure

- Check supply by pushing up on the feeder hole or checking slot in cabinet that shows supply level.
- Unlock cabinet.
- Remove paper wrapper from new package of towels and place towels in dispenser, **fold down,** on top of towels already there. (See *Figure 9-41.*)
- Lock cabinet.
- Wipe entire surface of dispenser and area

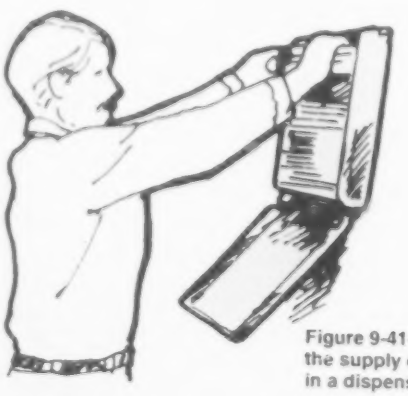


Figure 9-41—Replenishing the supply of paper towels in a dispenser.

around dispenser with a damp pad of cloth. Remove dirt with cleaning solution as necessary.

Soap Dispenser

- Check level of soap in dispenser.
- If more is needed, remove cap, using tool provided.
- Fill with liquid soap from squeeze bottle. Leave air space at top of dispenser.
- Replace cap and wipe dispenser with a damp pad of cheesecloth.
- Dry and polish with dry pad.

Toilet Tissue Dispenser

- Replace roll with new roll as needed.
- Wipe holder and surrounding area with a damp pad.

Storage

- Clean all tools and store on custodial cart in a locked custodial storage room.
- Store towels and paper products on top shelves in a locked storage area. Paper products are kept on top shelves to protect them from possible spilling of liquid supplies.

14 SPOT WASHING—GRAFFITI REMOVAL

Job Description

Removing hand prints, smudge marks, gum deposits and graffiti from walls, and spot cleaning of painted or vanished surfaces around light switches and door knobs may be done by an area custodian or a team assigned to the project, depending on the size of the job.

Precautions

- If a ladder is used, do not stand above the third step from the top.
- Do not let water run down the wall or onto the floor, as it will streak.

Time Guidelines

- Three minutes or more depending on size of area, kind of dirt to be removed and other variables.

Equipment

- Cheesecloth or cloth pad
- Cleaning solution
- Spray bottle
- Cellulose or natural sponges
- Sponge mop
- 16-quart pail on castors
- Rubber gloves

Spot Cleaning Procedure

- Spray smudge mark with a mild solution of cleaner and water from spray bottle. (See *Figure 9-42.*)
- Rub dry with cloth or sponge.
- Do not let cleaning solution run down the wall or onto the floor since it can leave streaks.

Washing Ceramic Walls

- Spread a mild solution of cleaner and water on the wall with sponge mop or with a cellulose or natural sponge.
- Do not let water run down wall or onto floor.
- Wipe dry with a clean, dry cellulose or natural sponge.

Storage

- Rinse out cloth and hang to dry. Sponges should be rinsed and wrung as dry as possible.
- Stand sponge mop to dry.
- Rinse and dry out pail.

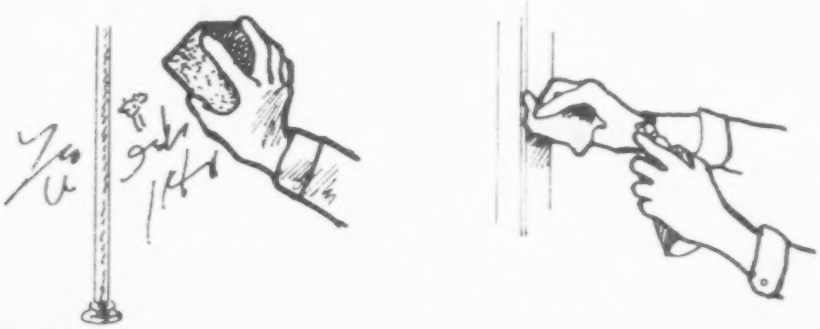


Figure 9-42—Spray a cleaner solution and rub with cloth pad or sponge to remove smudges or graffiti from walls.

• All tools and equipment should be stored in a locked storage room.

15 WALL WASHING

Job Description and Frequency

There are several ways to wash walls. Directions below cover hand washing. If a machine is used, follow manufacturer's directions. A regular schedule of wall washing and repainting should be established to maintain desired appearance.

Precautions

• Avoid spilling cleaning solutions on an unwashed wall. This causes streaks that are difficult to remove.

• Avoid splashing or spotting ceiling.

• Move furniture, pictures and other items carefully to avoid any damage.

• Be sure stepladders and scaffolding are in sound condition and in compliance with applicable safety requirements and use them carefully.

Time Guideline

• 1 to 4 hours per 1,000 square feet

Equipment

• Buckets
• Sponges
• Turkish towels
• Stepladder or scaffolding
• Dust mop
• Broom
• Drop cloths
• Cleaner
• Rubber gloves

Procedure

• Assemble tools and supplies in room or area where job will be done.

• Move furniture to the center of the room or into another room if possible. If furniture remains in room, cover it with a drop cloth.

• Remove pictures and other items on walls and place in a safe storage place.

• Dust walls lightly. Use an upward and outward lifting stroke to remove cobwebs without smearing walls. (See *Figure 9-43.*)

• Set up stepladder or scaffolding and be sure it is safe (see *Figure 9-44*). Mix recommended amount of cleaner in pails.

• Put on rubber gloves.

• Immerse towels or sponge into wash solution and squeeze out excess liquid.

• With towel or sponge, apply liquid to the wall in a corner next to the floor.

• Work from bottom up.

• Wet area about ten feet square, without rubbing.

Figure 9-43—Dust walls lightly before washing. Lift dustmop upward and outward to remove cobwebs without smearing.

Figure 9-44—Use safe measures in washing upper walls or ceilings from a scaffold or stepladder.

• Again immerse towel or sponge in cleaning solution; squeeze out excess so it does not drip.

• Repeat washing sequence, but this time apply pressure to clean off soil. A straight rubbing motion, either up and down or side to side is most effective.

• Rinse with sponges or toweling **before** wall dries. Rinse completely, then wipe dry with clean sponges or toweling.

• Repeat operation on adjacent section of wall, overlapping the cleaned area to avoid border marks.

• Wash areas about ten feet square until lower half of wall is finished. Locate stepladder at a corner and begin washing upper half of wall.

• Begin at bottom of upper half and work up. Use the same method as for lower half of wall.

• When solution runs or is splashed onto the clean wall below, wipe it off promptly with a clean damp towel.

• When the room or area is finished, pause and look over job.

• Remove drop cloths and replace pictures and other objects on walls. Return furniture to exact location it was moved from.

• Throughout the job, replace wash and rinse water as they become dirty.

• Empty buckets, wash out towels and sponges, and clean all equipment before storing it in a locked storage cabinet. Wet cloths and sponges should be hung or stored to allow them to dry.

16-1 WASTE REMOVAL

Job Descriptions

Usually trash and paper are gathered and waste receptacles emptied each day. (See *Figure 9-45.*) Trash must be removed from the building on a regular basis to avoid the danger of fire. Usually trash is dumped into large containers kept outside.

Precautions

• Establish waste removal procedures that are consistent with environmental standards and with requirements for handling any hazardous materials. See Chapter 6, especially the section on Waste Management.

• Always check weight of waste containers before lifting, especially in shop areas where heavy wood or metal shavings may be in the trash.

• Keep hands out of waste containers. Use both hands on outside of container to lift and dump trash (see *Figure 9-46*).

• Do not bend over collector can when dumping wastebaskets.

• Get help to dump a heavy load into the trash collector.

• Use correct lifting procedures to avoid straining back.

• Consult school district policies and procedures regarding the use of protective clothing and methods of disposal where hazardous materials may be involved.

• If there are steps leading up to large outside collectors, be sure they are free from ice and snow and clear of objects.

Time Guidelines

• 1 to 5 minutes per unit depending on unit size and type of waste.

• 10 to 30 minutes per trip to outside collector, depending on distance, size of containers, and other obstacles.

Equipment

- Custodial cart
- Collector can (see *Figure 9-47*)
- Metal drum
- Four wheel cart
- Wastebasket
- Leather or leather palm gloves
- Rubber or plastic apron
- Safety glasses or goggles
- Respirator
- Safety shoes

Figure 9-45-A typical waste container.

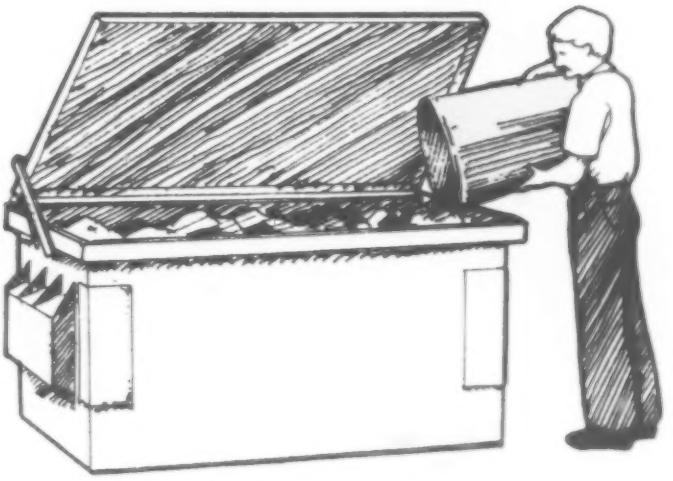


Figure 9-46—For safety, use both hands on outside of container to dump trash.

Procedure

- Develop a pattern that avoids doubling back.
- It is usually easier to push a cart than to pull it.
- Reduce flying dust from trash by turning wastebasket over and holding it down inside the receptacle when emptying.
- Check weight of container.
- Lift container with both hands, keeping hands outside container.
- Turn container upside down into collector can. Hold your head back and look away to avoid getting dust in the face or eyes.
- Hold container in this position for a second or two to make sure all dust and debris has settled.
- When cart or collector can or drum is full, carry trash to large outside collector.
- It is better to make several smaller trips than to try to carry too large a load to outside collector.
- Be sure waste containers are replaced in proper location. Never set containers on table or desk.
- When replacing a container, be careful not to bump walls or furniture.

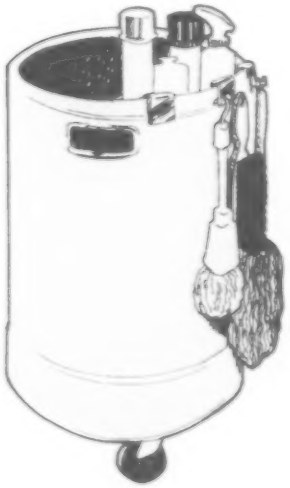


Figure 9-47—A collector can on castors can be equipped with basket and hooks to carry needed supplies and equipment.

16-2 WASTE REMOVAL — LARGE CONTAINERS

Job Description

Large trash containers normally are located outside the building because of the possibility of fire. After trash is collected from the assigned cleaning area, it is dumped in the large container.

Precautions

- If there are steps leading up to the collector, use extreme caution. Be sure they are clear of ice, snow or objects. Always be aware of the danger of slipping and falling.
- Be sure lid springs are operable and that the lid has not frozen shut.
- Never get on top of or into a large trash collector.
- Always keep the lids to large collectors closed.

Time Guideline

• 10 to 30 minutes per trip depending on travel time, size of containers, number of steps and so forth.

Procedure

• It is safer and easier to dump several small loads than to overload the collector can.

• Inform supervisor if large trash containers are filled before scheduled pickup.

17 WAXING FURNITURE

Job Description

Office and classroom furniture, such as desks, chairs, tables and files, should be cleaned and waxed regularly to preserve the finish (see *Figure 9-48*).

Precautions

• Be careful to protect eyes when spraying cleaner or wax.

• Overspray onto floor surface will leave floor slippery. Wipe up any overspray at once.

Time Guideline

• 5 to 10 minutes per unit, but times vary widely. It is best to develop individual guidelines.

Equipment

• Cleaning solution
• Cloth or pad
• Furniture wax
• Pail

Procedure

• A regular schedule should be established so that some waxing and cleaning of furniture is done daily or weekly.

• Use a mild solution of cleaner and water to wash furniture if wax being used does not serve as a cleaner. Rinse and dry furniture before applying wax.

Liquid Wax

• Follow instructions on container.
• Shake container before using.
• Wet a cloth pad thoroughly with wax.
• Wipe over entire surface to be treated, using straight movements rather than circular.
• Let wax dry thoroughly.
• Wipe off haze with a clean pad of cloth, turning the pad often.

18 WINDOW WASHING

Job Description and Frequency

Typically, custodians work in teams to wash exterior windows and clean venetian blinds. A typical schedule for window cleaning is twice a year, inside and out. If special conditions exist, more frequent cleaning may be needed. Venetian blinds are dusted and washed as needed. Screens and storm windows are usually cleaned once a year.

Precautions

• Exterior window washing is hazardous. Use caution at all times. Follow correct procedures in

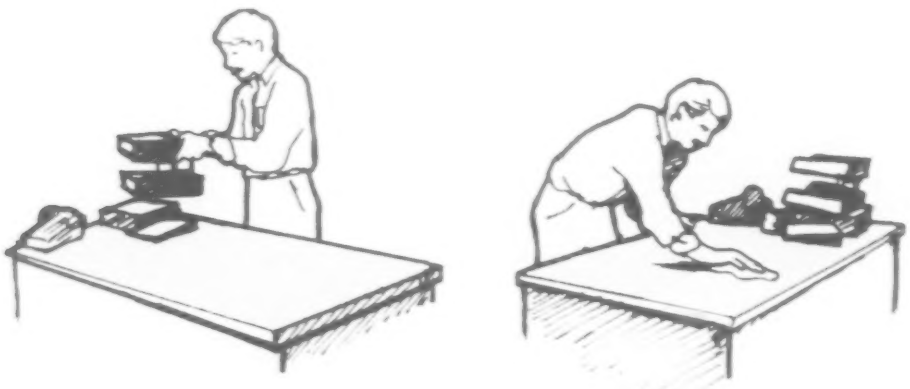


Figure 9-48—To spray wax furniture, first move items to one end of desk; lightly spray one-half of desk and wipe immediately with cloth (do not allow spray to dry); then repeat the procedure on the rest of the desk. Replace all items in their original positions.

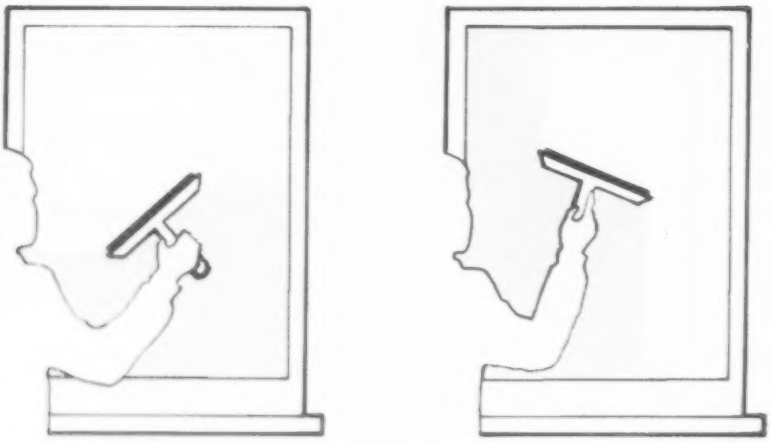


Figure 9-49—Efficient squeegee motions make water run toward trailing edge and away from cleaned area.

using ladder and safety belt.

- Check safety equipment carefully before beginning job.
- When washing the insides of windows, never stand on radiators, desks, fans, chairs or other furniture or equipment.
- Never stand above the third step (or rung) from the top of a ladder.

Time Guideline

- Depending on size and location of window, 8 to 15 minutes per unit.

Equipment for Cleaning Windows

- Window cleaning solution
- Buckets
- Cloth pads
- Detergent pellets
- Hose
- Ladders: straight and step
- Window cleaning telescoping pole with hose and brushes
- Sponges
- Squeegees (6, 10, or 14 inch)
- Window safety belts
- Window cleaner

Equipment for Cleaning Screens

- Hose
- Pistol grip nozzle
- Plastic bristle broom

Procedure for Washing Inside of Windows

- Arrange equipment and prepare supplies.
- Raise venetian blinds or shades and remove all items from window sills. Take care not to damage sills.
- Wash glass with sponge and water, with or without cleaner. Use left-to-right, then up-and-down overlapping strokes to clean entire glass surface. Use stepladder to clean upper sash first.
- Use squeegee to remove water, using either side-to-side or top-to-bottom movements. (See *Figure 9-49.*)
- If using side-to-side method, make one continuous stroke. Start with squeegee in a vertical position at an upper corner and stroke across to opposite side. Make a half-turn and return. Continue back and forth in overlapping strokes. Excess water will collect in the lower corner of the window.
- If using the top-to-bottom method, move the squeegee in separate strokes.
- With a sponge or cloth pad, wipe blade of squeegee after each stroke.
- Use sponge or cloth pad to wipe up water.
- Check work, then replace items on window sill. Leave blind or shade in the position in which you found it.

Procedures for Washing Outside of Window

Safety Belt Method

- Arrange equipment and prepare supplies. Be sure to inspect belt, checking buckle, ropes and hooks to be sure they are in proper working order.
- Put on safety belt and adjust by holding a hook in each hand and stretching arms outward until hands are about shoulder height. Check rope for proper length.

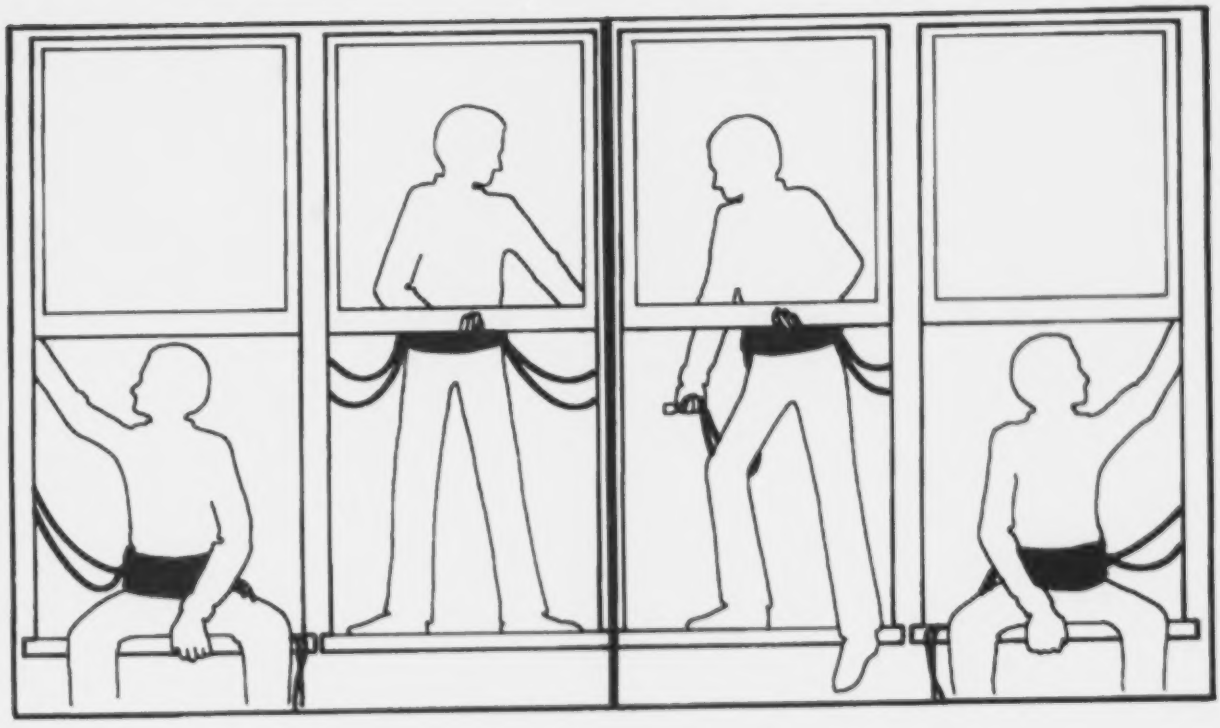


Figure 9-50—To ensure safety, proper procedures must be followed when going outside of a double hung window (left) and re-entering (right) after cleaning.

• To go outside double hung windows, then return: fully open lower window sash, sit on window sill with both legs inside and hold onto sill with one hand. Inspect all window bolts to see that they are anchored and undamaged. Use one hand to hold onto lower portion of window sash and use the other hand to hook the terminal of one side of the safety belt rope to the adjacent window bolt. (See *Figure 9-50.*)

• Check hook-up by pulling on anchored end of belt. Cautiously rise to a standing position while holding anchored side of rope with one hand and the bottom part of the window sash with other hand.

• After balance is certain, move the hand from the anchored rope to the bottom of the sash and use the other hand to hook-up the other end of the rope to the other window bolt.

• Check the hook-up. Lower the raised window sash.

• Use sponge and water, with or without cleaner, to wash glass, starting with the upper sash. After cleaning glass, framework, and sill, prepare to go back inside.

• Fully open lower window sash. Use one hand to hold onto the bottom of the window sash, using the other hand to unhook one end of rope from the window bolt.

• After one end is unhooked, sit down on window sill with both legs inside. Use one hand to hold onto window sill and the other to unhook the second end of the rope from the window bolt. After second terminal is unhooked, return inside and close the window.

Pole Washing Method

• Pole washing procedure may be used to clean water-tight windows which are 50 feet or less

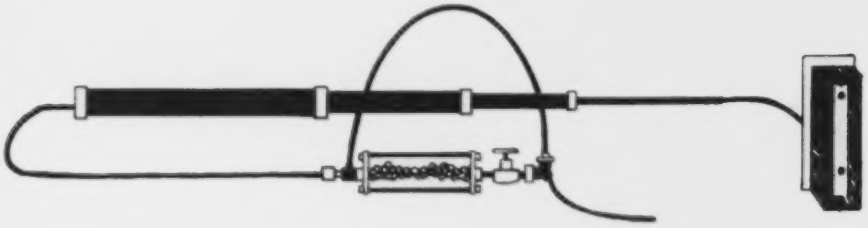


Figure 9-51—Window washing pole unit can be connected to a water supply and equipped with a canister of cleaning pellets.

above ground.

• Arrange equipment and prepare supplies for work. Up to five people and two pole window washing units may be used. Two people operate one unit to wash windows, two operate the second unit and rinse. The fifth person works inside, closing windows, drying up water that seeps in, and checking the work. (See *Figure 9-51.*)

Other Methods

On buildings with windows 50 feet or more above ground level, tubular or swinging scaffolding may be used.

Storage

All tools and supplies should be cleaned after each use and stored in a locked storage room.

10 / Equipment and Supplies

The school custodian uses dozens of different kinds of tools, equipment and consumable supplies. It is important for the custodian to know as much as possible about these items—what they are, how they should and should not be used, and any hazards that might be involved.

It also is essential for all members of the maintenance team to receive regular training and informational briefings to keep up-to-date with new products and to ensure that all equipment and supplies are used in accordance with district policies.

This chapter describes more than three dozen of the tools, equipment and supplies typically used by the school custodian. Each description includes an explanation of uses, care and storage, and any precautionary measures necessary.

Items are listed in alphabetical order.

ALL-PURPOSE CLEANER (APC)

All purpose cleaner (APC) is usually a detergent in either powder or liquid form. See *Figure 10-1*. It should always be used according to manufacturer's instructions. Most APCs are powerful and can cause damage if used in a solution that is too strong. Therefore, check with your supervisor before using extra-strong solutions.

The addition of any other cleaning agent to the chemically-balanced detergent can destroy its cleaning power. If there is a question, check the container for instructions.

Uses

APC may be used for the following jobs:

- Water mopping floors
- Cleaning floors for refinishing

Figure 10-1—Various forms of all-purpose cleaner include pre-measured packets of powder (left) and liquid in 5-gallon buckets and 55-gallon drums.

Equipment and Supplies, original chapter by Jack T. Harroun, University of Illinois (retired). Third Edition review by John Mannix, Director of Building and Grounds, Evergreen Park (IL) Community High School. New information also has been supplied by William C. Bradley, of C & W Bradley, P.C.

• Daily cleaning of toilet fixtures and drinking fountains
• Spot cleaning
• Cleaning furniture

Care and Storage

Liquid APC is normally received in cans. Powder APC is shipped in air-tight containers. All APC should be stored in a locked, dry custodial storage room.

Caution

Never add anything but water to a cleaning mixture of APC.

ABRASIVE CLEANER

Abrasive cleaner should rarely be used on any surface, and then only for removing stubborn stains. It should never be used on stainless steel or glazed surfaces such as Lexan or acrylic.

After abrasive cleanser is used, the area should be thoroughly rinsed and wiped dry.

Care and Storage

Abrasive cleaner is usually packaged in cans or bottles, and should be stored on shelves in a dry, secure custodial storage room. See *Figure 10-2.*

Caution

Improperly used, abrasive cleaner roughens the finish and makes cleaning more difficult. Abrasive cleaner should not be used in any daily procedure unless there is no other way to do the job.

AMMONIA

Two or three tablespoons of ammonia per gallon of water can be used to clean glass.

Care and Storage

After use, clean the outside of the bottle and store it in a locked custodial area. See *Figure 10-3.*

Caution

Ammonia is a poison. Avoid inhalation of ammonia fumes. Do not mix other cleaners with ammonia, especially chlorine cleaners. This is a limited-use product.

BOWL CLEANER APPLICATOR

This applicator (johnny mop) is used with liquid bowl cleaner to clean stools and urinals. See *Figure 10-4.* Full-strength bowl cleaner or all-purpose cleaner is applied directly on the applicator. Avoid dripping cleaner on floors. All rims, grooves and inside surfaces are scrubbed with the applicator.

Figure 10-2—Abrasive cleaner.

Figure 10-3—Ammonia

Care and Storage

After use, rinse out the applicator, squeeze out excess water, and hang it to dry on a custodial storage cart in the storage area.

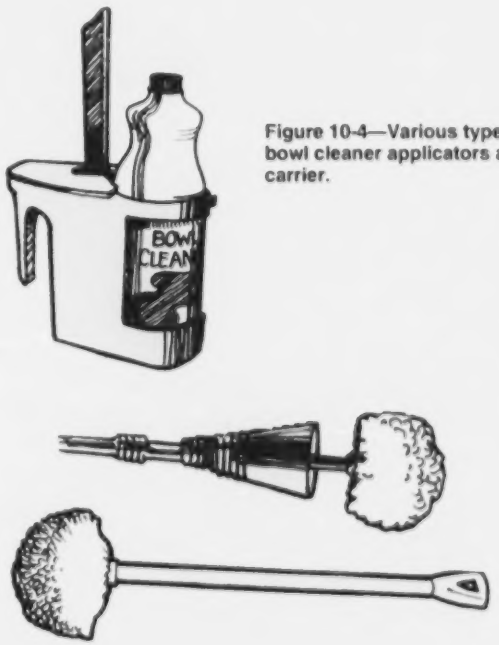


Figure 10-4—Various types of bowl cleaner applicators and carrier.

BOWL CLEANER

Bowl cleaner is used to clean vitreous china toilet bowls and urinals only. Under normal conditions, the frequency of use depends on the hardness of the water. Normally once a week is sufficient. See *Figure 10-5.*

Care and Storage

Supplies of bowl cleaner must be stored on a bottom shelf in the custodial storage room for safety in case of spillage.

Caution

Bowl cleaners contain acid and must be used carefully to avoid injury or damage to property. Do not mix bowl cleaner with any other cleaner. Handle carefully and avoid contact with skin or prolonged inhalation of fumes.

Figure 10-5—Bowl cleaner in dry forms and liquid.

BROOMS

Brooms should be made from cornstraw, equipped with splinter-free wooden handles, and sewn with good quality twine. See *Figure 10-6.*

Use

Brooms are used to clean rough floors, porches, and, if necessary, wet floor areas.

Precautions

Never dry sweep material that may contain asbestos dust or lead dust or paint chips. See your supervisor of designated asbestos person.

Care and Storage

Clean brooms and store in a rack in a locked custodial storage room so that no weight or pressure is on the straw.

Figure 10-6—Brooms in various types and sizes.

CHALK AND ERASERS

Generally dustless chalk is used. Most erasers used are double-sewed felt erasers.

Use

Two or three long pieces of chalk and one eraser should be provided for each three to four foot section of blackboard unless other directions are given. See *Figure 10-7.*

Care and Storage

Small supplies of chalk and erasers should be carried on the custodial cart. Larger supplies of chalk and erasers should be stored on the shelves

Figure 10-7—Chalk and eraser.

in the locked custodial storage room. Extra supplies may be left with teachers if requested.

CLOTH PADS

Cloth pads are available in various types of packaging. See *Figure 10-8.*

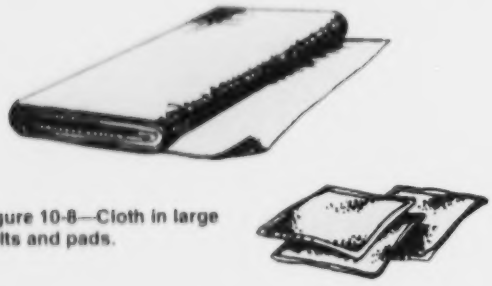


Figure 10-8—Cloth in large bolts and pads.

Use

Cloth pads can be used for many cleaning operations, including: cleaning and drying of drinking fountains, toilet fixtures, mirrors, and glass surfaces; washing and waxing furniture; spot cleaning painted walls, partitions, and doors; cleaning toilet seats, and many other purposes.

A readymade pad can be carried in the custodian's pocket at all times for quick dry dusting.

Care and Storage

Boxes of cloth pads should be stored on a shelf in the locked storage area. Used pads may be rinsed and hung up to dry in the storage area, then reused.

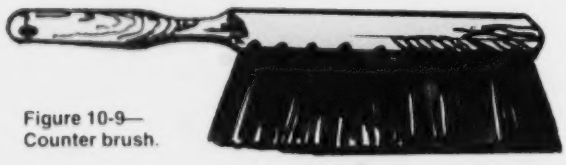


Figure 10-9—Counter brush.

COUNTER BRUSH

An eight-inch brush or the equivalent makes an acceptable counter brush. Handles should have a hole or screw eye for hanging the brush on the custodial cart. See *Figure 10-9.*

Use

The counter brush is used with a dustpan to pick up soil after sweeping or dustmopping, and to clean soil from hard-to-get-at areas. A toy broom also may be used with a long-handled dustpan for the same purposes. See *Figure 10-10.*

Figure 10-10—Toy broom and dust pan with a long handle (lobby pan).

Care and Storage

Clean counter brush bristles with the edge of a dustpan, and hang on custodial cart.

CUSTODIAL CART

The custodial cart is a "closet on wheels." The school custodian carries most of the supplies and tools needed for the day's work. The cart is also used to transport waste from the building to the trash collection area.

There are several types of carts:

- Some carts may have a detachable collector can for waste and several shelves for storage of supplies and equipment. Some models have broom or mop holders and hooks to hang equipment. See *Figure 10-11.*
- The collector can on castors is a light weight waste container, which may be equipped with a

half-moon basket for supplies that fits inside the container. See *Figure 10-12*. Hooks for equipment may be installed on the sides of the can. (Collector cans without castors are used for collecting waste in congested areas in buildings without elevators, and can be carried up and down stairs.)

- Four-wheeled platform trucks with one or two 55-gallon metal drums are used to collect waste in laboratories. They may or may not be equipped with shelves for carrying tools and supplies. See *Figure 10-13*.

Use

The cart should be stocked at the end of the shift with supplies needed for the next day. This eliminates extra trips back to the supply room.

In large open areas, the cart should be taken into the room to eliminate as many steps and as much doubling back as possible. If the cart cannot be taken into the room, remove the collector can and take it into the room with supplies and tools needed to clean that room.

In smaller areas, the custodian may use only the collector can with half-moon insert to carry supplies.

The custodian should always keep the cart as close to the work area as possible, and should never overload the collector can. It is easier and safer to make two trips to the large trash containers than to handle an overloaded can.

Care and Storage

All custodial cart waste containers should be emptied at the end of each day's use. Each custodian is responsible for keeping his/her cart clean and neat. The cart should always reflect the professional image of the school custodian.

All carts should be stored in a locked custodial storage room.

Figure 10-11—Here are three of the many ways to equip custodial carts for different needs.

Figure 10-12—A collector can on castors, which may be equipped to carry supplies (see Figure 9-47 on page 84).

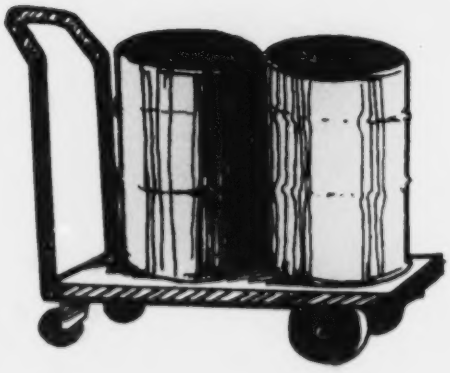


Figure 10-13—A platform truck with metal drums.

DUST PAN

The short-handled dust pan is constructed of one piece of steel and painted with black enamel. Long-handled dust pans are available as well and may be used with a toy broom. See *Figure 10-14*.

Use

The dust pan is used with a counter brush or a toy broom to pick up accumulated soil after sweeping or dustmopping.

Care and Storage

Clean soil from dust pan and hang on custodial cart for convenience.

ENTRANCE MATS

There are many types of entrance mats, including link-rubber entrance mats, corded rubber mats used outside the entrance, and walk-off mats used inside. All are available in various sizes to provide building occupants a place to remove dirt and water from their shoes. See *Figure 10-15*.

Care and Storage

Carpet-type mats are vacuumed periodically and thoroughly scrubbed as needed. Surfaces under recessed mats should be cleaned as needed, at least once a month.

All door mats are kept in locked storage rooms when not in use.

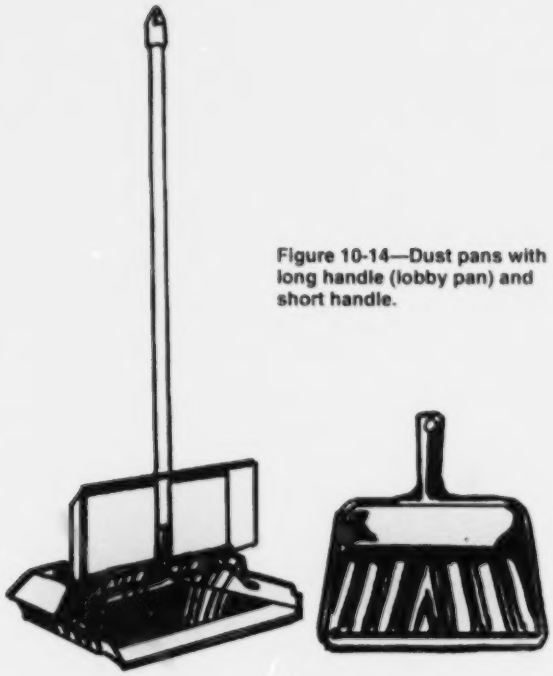


Figure 10-14—Dust pans with long handle (lobby pan) and short handle.

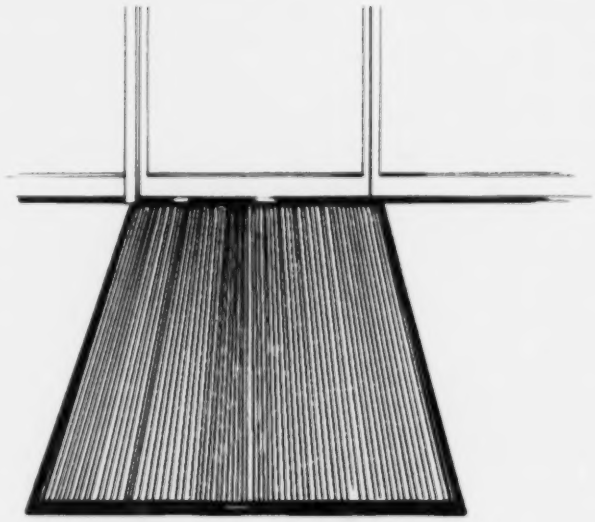


Figure 10-15—Carpet entrance mat catches dirt before it can be tracked further into the building.

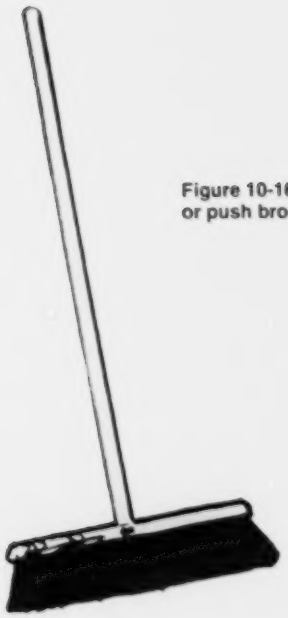


Figure 10-16—Floor brush or push broom.

FLOOR BRUSH

Push brooms or floor brushes are available in various widths. The width used depends on the size and congestion of the area to be cleaned. See *Figure 10-16.*

Use

Push brooms are used on rough floors for removal of heavy dry soil. Width of brush and length of handle should be carefully selected to reduce fatigue.

Care and Storage

Clean and store the broom in a broom rack in the locked custodial area so that no weight or pressure is on the bristles. Never store brooms near heat pipes or radiators. Comb bristles as needed. Periodically change the position of the broom handle.

Caution

- Do not use a push broom to sweep wet floors unless it is made with synthetic bristles.
- Never dry sweep materials that may contain asbestos, lead dust or lead paint. See your supervisor or designated person for asbestos.

FLOOR MACHINES

Floor machines are available in many brands and sizes. Normally, a 17-inch to 21-inch machine is used in schools, but select a size according to the area where it will be used. See *Figure 10-17.*

Use

Floor machines are used to refinish both hard and soft (resilient) floors and to shampoo carpets, according to manufacturer's instructions.

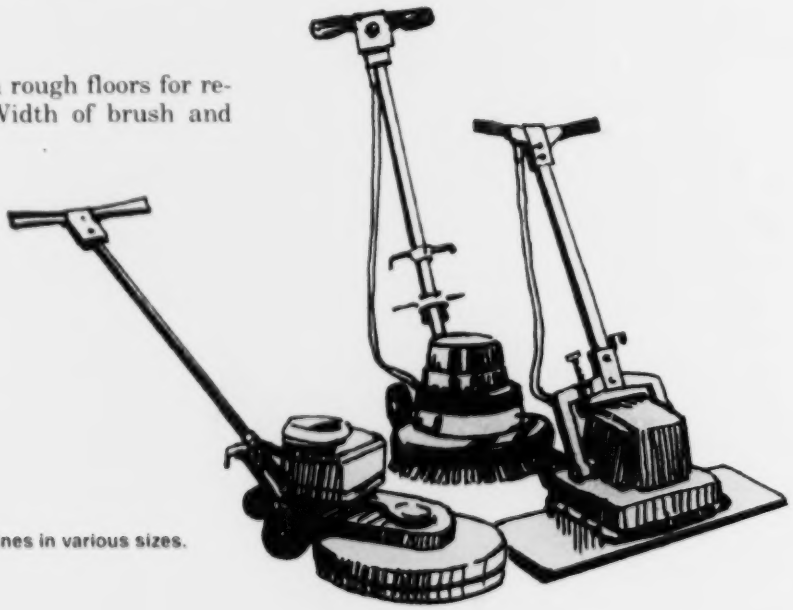


Figure 10-17—Floor machines in various sizes.

Care and Storage

After use, clean machine according to manufacturer's instructions and store in a locked custodial storage room. Before using, check the machine and electrical cord for possible needed repairs.

FUNNELS

One-pint plastic or metal funnels are useful for transferring liquids from one container to another. Always clean all spillage. See *Figure 10-18.*

Care and Storage

After use, clean and store funnel in storage area.

Caution

Do not use a metal funnel for acid-type cleaners.

FURNITURE POLISH

Furniture polish may be purchased in one-quart and other sizes, according to need. See *Figure 10-19.*

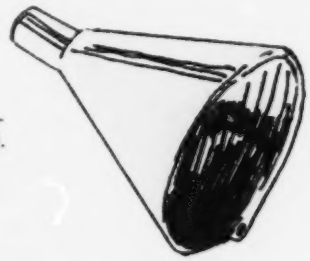


Figure 10-18—
Typical funnel.

Figure 10-19—
Furniture polish.

Use

Furniture polishes are used to clean and restore the surfaces of various types of furniture. Always follow instructions printed on the container label. Also check waxing instructions received with furniture for the best type of product to use.

Care and Storage

After use, clean outside of container and store it in a locked custodial storage room.

GEAR PRESS MOP UNITS

Gear press mop units are available in the 16-quart mop pail and downward pressure wringer unit and the 32-quart mop unit. Both units are equipped with castors. The 16-quart unit may be used in congested areas and the 32-quart unit in larger areas. See *Figure 10-20.*

Use

Gear press mop units are used daily in wet mopping. In using the 32-quart unit, fill the pail with three to four gallons of water. Fill the 16-quart unit with one and one-half to two gallons of water. Wherever possible, fill unit and empty waste water at a service sink.

Care and Storage

After use, rinse and wipe out the pail and store it upside down in the locked custodial storage room. Clean and store the wringer. Clean outside surfaces of the pail as needed. Oil castors as needed.

GLASS CLEANER

Window glass cleaner is used to clean all types of inside glass, such as display cases, desk tops and bookcases. See *Figure 10-21.*

Care and Storage

Keep outside of container clean. Store in a locked custodial storage area.

HAND DUSTER

A hand duster is normally 24 inches long and has a strong, rigid wire frame and a hardwood handle, which must have an eyelet or quarter-inch hole for hanging. Duster head is cotton yarn, double-stitched to sanforized canvas or a similar synthetic material. See *Figure 10-22.*

Figure 10-20—Typical mop buckets with press-type wringers.

Figure 10-21—Glass cleaner in a spray bottle.

Use

Duster head is treated with a dust controllant to pick up dust and avoid transferring it from one place to another. Most horizontal and vertical surface dusting is done with a hand duster.

Care and Storage

Hang the duster on the custodial cart and store it in a locked storage room. When the duster no longer holds dust, remove handle and place the duster in a designated area provided for pick up and laundering.

Figure 10-22—Hand dusters with removable duster heads.

Newly-laundered and treated duster heads should be neatly stacked on the shelves in the storage room. Do not remove plastic covering from the duster until ready to use. Since treatment dries out, always use the dusters in order received and never overstock the supply.

LIGHT BULB CHANGERS

Several types are available to change recessed or exposed bulbs. See *Figure 10-23.*

Care and Storage

Check changer for damage after each use. Store in a secure custodial storage room.

Caution

Always exercise caution when working with electricity.

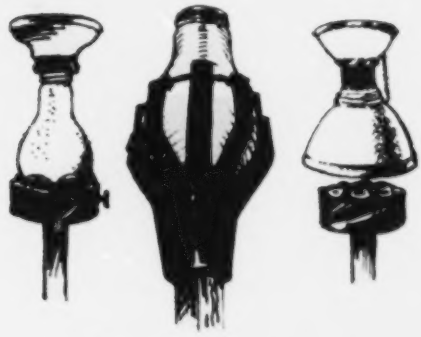


Figure 10-23—Light bulb changers for various types of bulbs.

METAL POLISH

Shake the container well before using. Put a little polish on a damp pad of cloth. When stains and tarnish are removed, allow polish to dry. Then polish metal with a clean cloth. Normally, cleaning metal is a periodic procedure.

Care and Storage

Polish may be stored on a custodial cart or on shelves in the custodial storage room. Outside and top of containers should be wiped clean after each use.

Caution

Most metal polishes may be used on most types of metal—copper, pewter, silver, brass, aluminum, nickel, bronze, tin, zinc; however, check instructions on the container.

MOPHEADS/STICKS (DRY)

Mopsticks with cotton mopheads are used for dry mopping (dust mopping). See *Figure 10-24*. Dry mops specially treated with a dust controllant are never used for wet mopping. Wedge-shaped mops are used for dry mopping in congested areas and on stair steps and may also be used for overhead dusting.

Care and Storage

Inspect mop after each work period and shake it out thoroughly to remove loose dirt. Inspect handle to make sure it is smooth and free of splinters. Broken or damaged handles should be exchanged for new ones. Soiled mopheads which have been treated with a dust controllant are gathered and placed in an assigned area for pickup, laundering and retreatment.

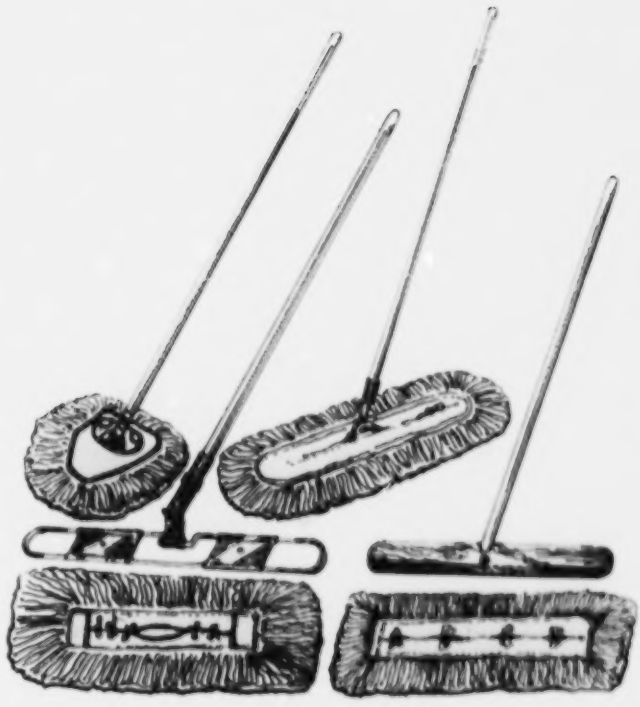


Figure 10-24—Dry mopheads and handles.

Treated mopheads tend to dry out in storage, so they should never be stored longer than two to three weeks, even if they are packaged.

MOPHEADS/STICKS (WET)

Mopheads used for wet cleaning are made from white cotton stock bound with fabric tape which is securely sewn with lock or chain stitching. See *Figure 10-25*. The handle must have a smooth finish. Several types of mopsticks are available.

Care and Storage

Inspect mops after each work period. Be sure handles are smooth and free from splinters. Replace broken handles. Thoroughly clean and rinse mophead and spread out to dry.

OIL DRY

Oil dry is a compound used in shops, garages or other areas where oil drippings are a problem. The drippings are sprinkled with oil dry, which absorbs the oil. Then the saturated oil dry is removed by sweeping.

Figure 10-25—Wet mopheads and handles.

Care and Storage

Oil dry is stored in a dry location in a locked custodial storage room. Clean any spillage promptly.

Disposal

Saturated oil dry may be considered a special waste that must be disposed of in accordance with requirements of your local waste disposal company.

PAILS

Twelve-quart pails are used in many cleaning procedures, including cleaning blackboards, washing and waxing furniture, spot cleaning and others. They may be metal or plastic. See *Figure 10-26.*

Care and Storage

Thoroughly rinse the pail before storing it in the custodial storage room.

Caution

Never put an acid-type product in a galvanized pail, as the pail may be damaged.

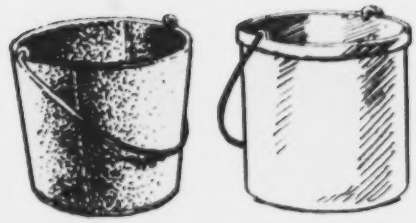


Figure 10-26—Pails in metal and plastic.

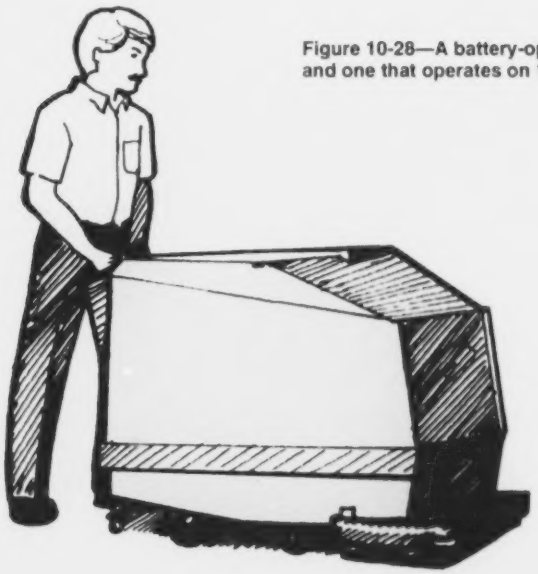
PLUMBER'S FRIEND

A plumber's friend is a force cup on a handle, used to unplug drains in lavatories, urinals and stools. See *Figure 10-27.*

Use

Use a wet paper towel or pad of cheesecloth to temporarily seal off the air vent of lavatories. Set the cup over the drain hole like a stopper. Push down on the handle to flatten the cup. Then pull the plunger out quickly. Do this several times to

Figure 10-27—Plumbers Friend.



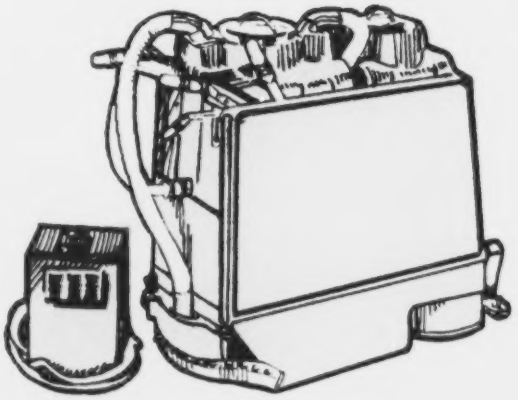


Figure 10-28—A battery-operated auto scrubber (right) and one that operates on 110-volt AC current.

loosen the material that is stopping the drain. If drain is still plugged, report it to your supervisor.

Care and Storage

Clean after use and store in a locked custodial storage room.

POWER (AUTO) SCRUBBERS

At least two types of auto scrubbers are available: battery powered, self-propelled machines with a portable battery charger and 110-volt electric power scrubbing machines. See *Figure 10-28.*

Use

These machines are used to wet clean large open areas. Use according to manufacturer's instructions for individual machines.

Care and Storage

Clean and drain the tanks of each machine prior to storage.

Caution

Charge battery-powered machines only in a well-ventilated area.

POWER SPRAY CLEANERS

The power spray cleaner is used to clean swimming pools, shower stalls, toilet areas and to remove graffiti from exterior walls. See *Figure 10-29.*

Use according to manufacturer's directions for individual machines.

Care and Storage

After each use, thoroughly clean machine, dry it and store it in a secured custodial storage room.

POWER SWEEPERS

Gasoline powered, self-propelled power sweepers are used to sweep large open areas. See *Figure 10-30.*

Figure 10-29—Power spray cleaning units.

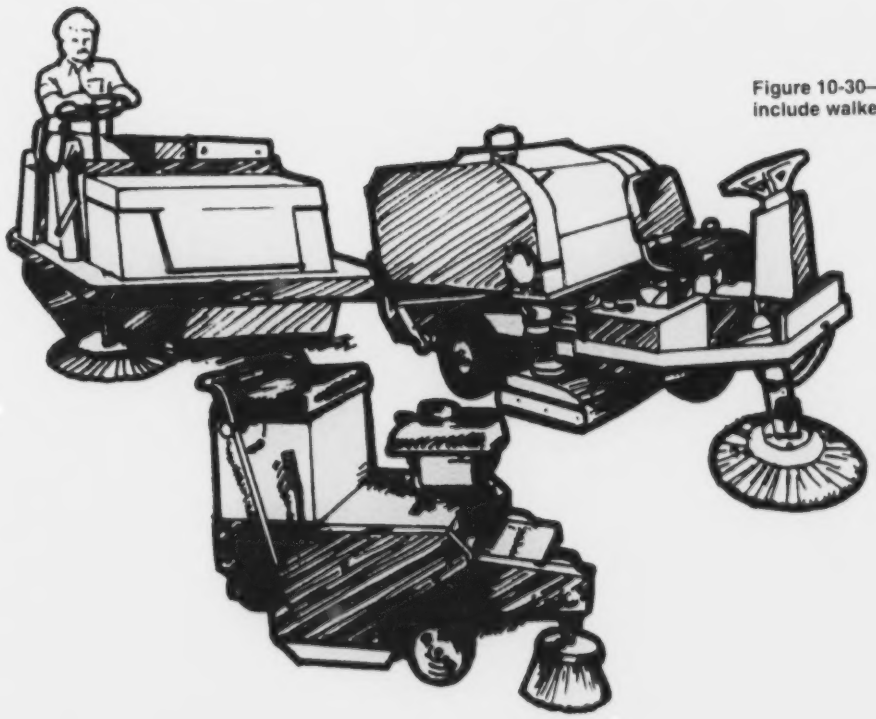


Figure 10-30—Power sweepers include walkers and riding types.

Use according to manufacturer's instructions for individual machines.

Care and Storage

After each use, the machine's dirt-catching hopper should be emptied, the filter cleaned, and the oil checked.

Periodic maintenance should follow manufacturer's directions.

PUTTY KNIFE

One-inch elastic putty knife is used to remove gum and other sticky soil from floors. See *Figure 10-31*. Gently pry soil loose, using care not to mar the floor covering.

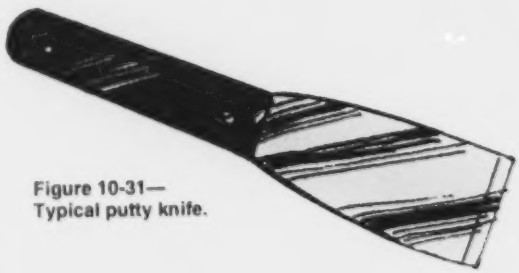


Figure 10-31—Typical putty knife.

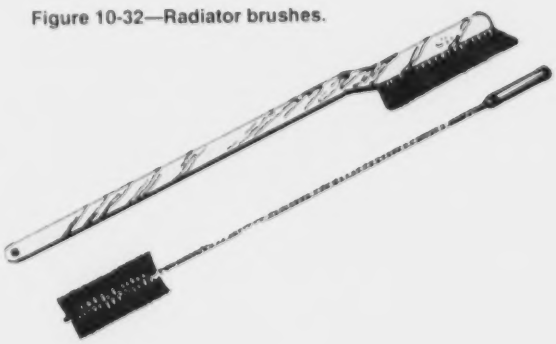
Care And Storage

Store on the custodial cart or in a locked custodial storage area.

RADIATOR BRUSH

The radiator brush is approximately 30 inches long, with a wooden or metal handle. See *Figure 10-32*. It is used to clean between coils, behind and under radiators.

Figure 10-32—Radiator brushes.



Care and Storage

Hang on the custodial cart.

Figure 10-33—Scrub brushes come in a variety of shapes and sizes.

SCRUB BRUSHES

A scrub brush normally is made with a palmetto fiber and may have a long handle. See *Figure 10-33.*

Use

The scrub brush is used in the cleaning of swimming pools and may be used in other areas where it is not practical to use power scrubbing machines.

Care and Storage

After use, thoroughly rinse the brush and store it in the custodial storage room. The weight of the brush should not rest on the bristles.

SPONGES

Natural and cellulose sponges are used in a number of cleaning jobs. See *Figure 10-34.* Large sponges may be used to wash chalk boards and smaller ones for spot cleaning and similar tasks.

Care and Storage

Sponges are expensive and proper care is important for long life. After use, wash out the sponge and store it in the custodial storage room in a spot where it will dry completely.

SQUEEGEES (FLOOR)

Floor squeegees, available in many shapes and sizes, are used to push water or cleaning liquids on floors to a drain or a place where the liquid can easily be removed. See *Figure 10-35.*

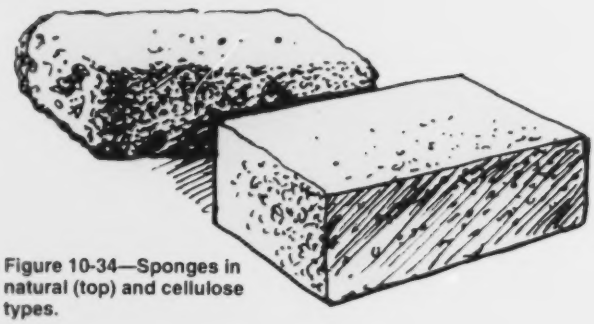


Figure 10-34—Sponges in natural (top) and cellulose types.

Care and Storage

Wipe blade dry and inspect after each use. Replace blade as needed. Store the squeegee in a locked custodial storage room so that its weight is not on the rubber blade.

SQUEEGEES (WINDOW)

Window squeegees, which are used to clean glass, chalk boards and windows, are available in several sizes: 8, 10, 14 and 18 inches. Rubber refills may be purchased in three-foot lengths and cut to size. See *Figure 10-36.*

Care and Storage

Wipe blade dry and inspect after each use. Replace blade as needed. Store squeegee on a hook in custodial storage room so that its weight is not on the rubber blade.

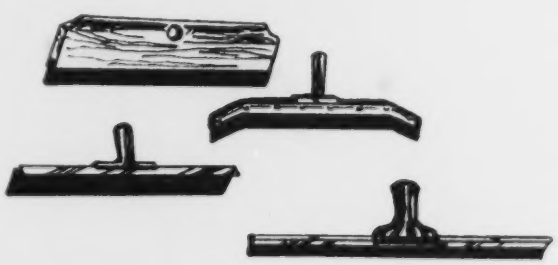


Figure 10-35—Floor squeegees.

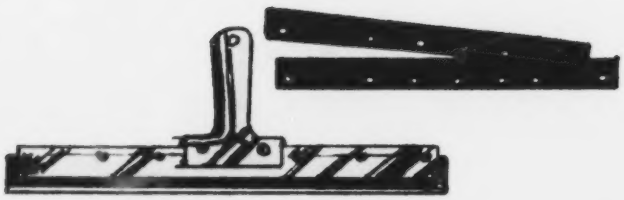


Figure 10-36—Window squeegees.

STEPLADDERS/SCAFFOLDS

Several sizes of heavy duty, rungback, safety platform ladders and scaffolding are available. Select a size according to need. See *Figure 10-37.*

Use

Carefully inspect any stepladder or scaffolding and place it in a secure position before performing any work from it.

Cautions

In using a stepladder or scaffold, always maintain a stable position and use it in accordance with government safety standards.

Figure 10-37—Scaffold (left) and platform ladders.

Care and Storage

After use, store the stepladder or scaffold in a locked custodial storage room. Clean equipment as needed so it always has a neat appearance.

Check equipment for safety before each use.

STREET BROOMS

Heavy duty street brooms with extra heavy hardwood handles are best. See *Figure 10-38.*

Use

Street brooms are used to clean machine shop floors made of wooden blocks. They also are used to clean rough floors, ramps, and exterior areas such as streets or sidewalks.

Figure 10-38—Heavy-duty street broom.

Care and Storage

Clean and store the broom in a broom rack in the custodial storage room so that no weight or pressure is on the fibers. Reverse position of handle periodically to allow even wear.

TANK SPRAYERS

Tank-type liquid sprayers come in a variety of sizes. Select according to planned use. These units may be used in toilet room cleaning or for spraying on finish. See *Figure 10-39.*

Care and Storage

Thoroughly clean, dry and store in a secure custodial storage room after each use.

Figure 10-39—Tank-type liquid sprayer.

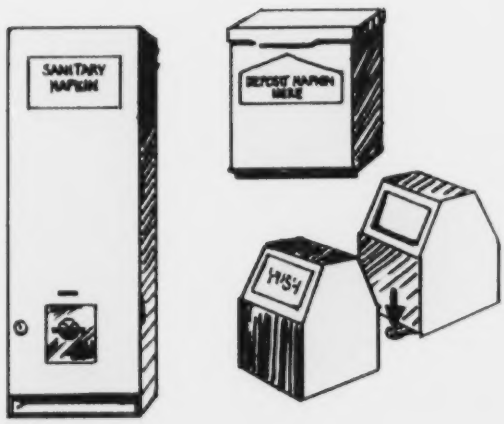


Figure 10-42—Sanitary napkin dispensers and receptacles.

TOILET SUPPLIES

Toilet supplies are checked and replenished as needed. These include:

- Toilet paper. Install at least two toilet paper holders in each stall so extra paper is always available. See *Figures 10-40* and *10-41.*
- Wax bags. These are used to line sanitary napkin receptacles. If they contain waste, they are removed and the receptacle relined with a new bag.
- Sanitary bags are placed on back of the door or other suitable location in each stall in all women's toilets. See *Figure 10-42.*
- Toilet soap is placed in dispensers provided. Liquid toilet soap normally is available in one-or five-gallon containers. Granular toilet soap is ordered by the pound. See *Figure 10-43.*

Care and Storage

All toilet supplies are stored in the locked custodial storage area, in a place where they will not become soiled. All dry supplies should be stored on upper shelves to avoid damage by leakage or accidental spillage of liquid supplies.

TOWEL CABINETS

Towel cabinets are located in all toilet areas and in laboratories and other locations. The custodian is responsible for periodic service checks to replenish the towel supply, as needed, with folded and rolled paper towels. See *Figure 10-44.*

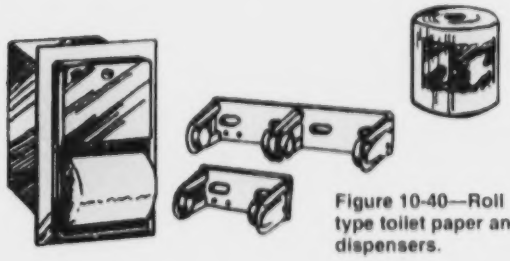


Figure 10-40—Roll type toilet paper and dispensers.

Figure 10-41—Tissue type toilet paper (single and double fold) and dispenser.

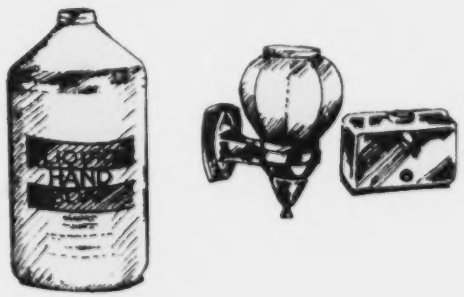


Figure 10-43—Liquid soap and two types of dispensers.

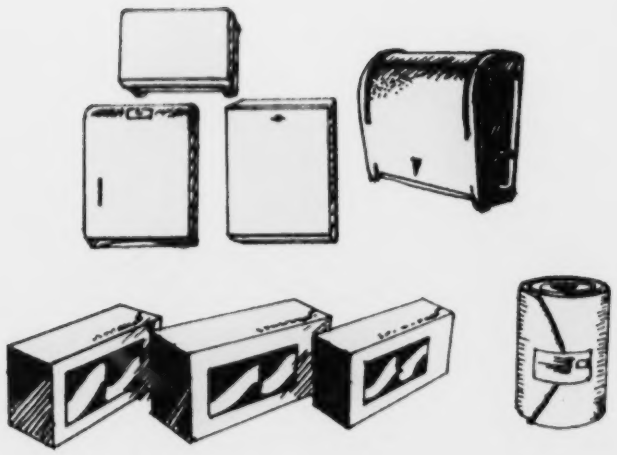


Figure 10-44—Towel cabinets (above) and paper towels come in various types—C-fold, single fold, multi-fold, and rolls.

Use

For instructions in operating cabinets, see the inside of each cabinet. In addition to replenishing supplies of towels, the custodian should dust towel cabinets daily and spot clean as needed. Soiled paper towels are placed in a waste container which is emptied daily or as needed.

Care and Storage

Supplies of towels should be neatly arranged on shelves in the locked custodial storage room, above any liquids to avoid damage by spillage or accidental leakage.

TREATMENT, DUST MOP

Dust mop treatment is an aromatic liquid chemical used to treat cotton strand and other dust mops. The chemical aids in collecting dust and loose dirt from sealed, finished or waxed floors of all types.

Use

Amounts used vary with floor type and condition.

A mophead may be refurbished periodically by sprinkling a few ounces of treatment on it to keep it from drying out. If a newly-treated mop leaves streaks on the floor, it may have been overtreated and should be allowed to stand and "cure" longer.

When the newly-treated mop leaves dust on the floor, it does not contain enough dust control treatment and should be lightly sprinkled with more treatment and allowed to stand overnight.

Care and Storage

After use, clean the outside of the mop treatment can and store it in the locked custodial storage room. Never store a treated dry mop or mop treatment near hot pipes.

Caution

Excessive use of treatment on mops may damage soft floors. Some mop treatments are flammable and should be avoided.

VACUUM CLEANERS

Several types of vacuum cleaners are available:

- Wet-dry vacuum cleaners are used to remove liquids from floors in wet mopping or in case of flooding. See *Figure 10-45*.
- Upright brush-type vacuum cleaners are part of the custodial equipment in any school with rugs or carpets. See *Figure 10-46*.
- Tank-type dry vacuum cleaners are used to remove dust or dirt.

Figure 10-45—Wet-dry vacuum cleaner picks up liquids, such as in wet mopping.

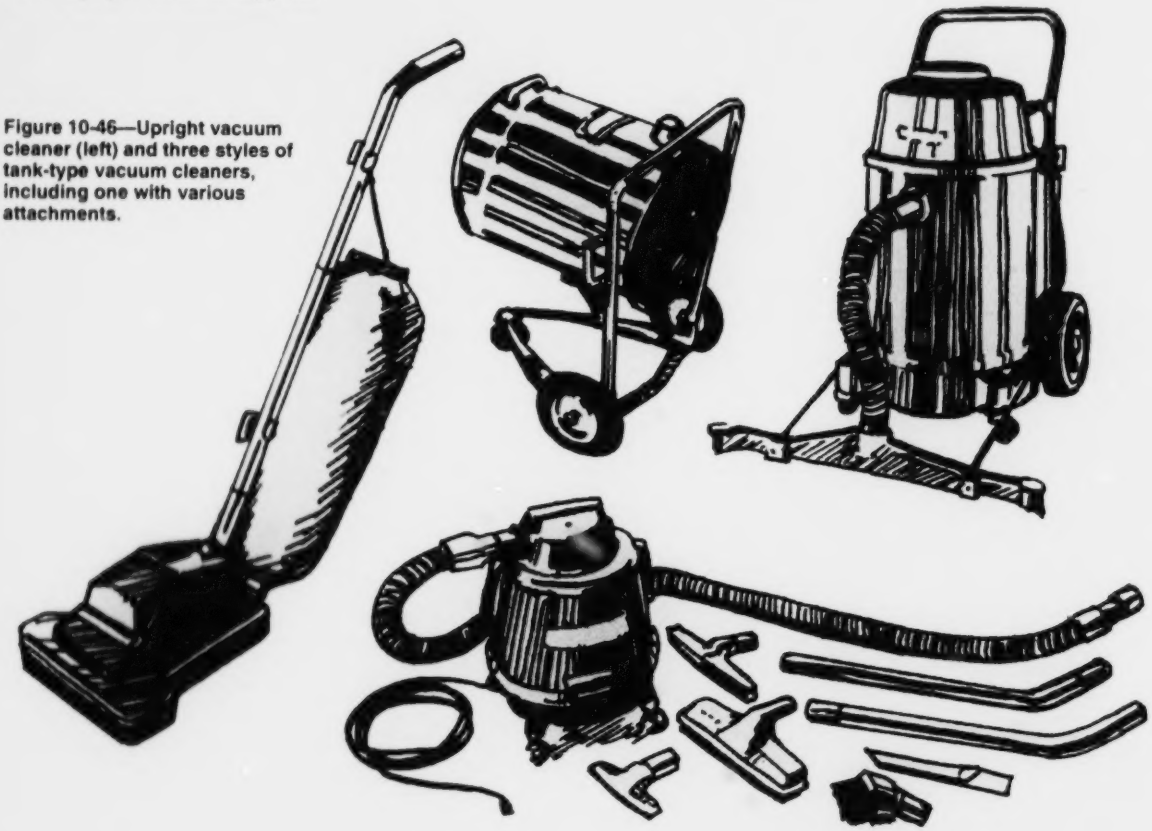


Figure 10-46—Upright vacuum cleaner (left) and three styles of tank-type vacuum cleaners, including one with various attachments.

Use

All rugs or carpets should be vacuumed regularly, as this increases the life of the rug by removing sharp gritty particles that can grind the fibers.

Vacuum cleaners have several parts and attachments for specific uses. See the manufacturer's directions for each machine.

Precautions

- A dry vacuum cleaner should not be used to remove liquids.
- Never use a regular vacuum cleaner to vacuum any type of asbestos or lead dust.

Care and Storage

Vacuum cleaners should be properly cleaned after each use, following manufacturer's directions. Needed repairs should be reported to the supervisor. All vacuum equipment is stored in a locked custodial storage room.

WASTEBASKETS

Several sizes and types of wastebaskets may be used. See *Figure 10-47*. These should be located throughout the school where they will be used by building occupants.

All wastebaskets should be emptied regularly. Care should be taken to avoid striking furniture

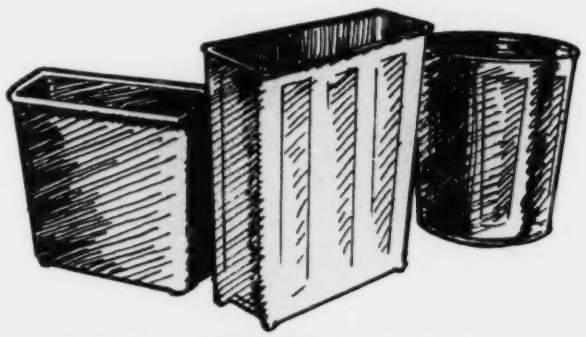


Figure 10-47—Wastebaskets typically located throughout the school.

11 / A Custodian's Glossary

ABRASION - Wearing away or cleaning by friction.

ABRASIVE - A substance used to scour, scrub, smooth or polish. Abrasive particles are found in such products as cleansers, pumice stones, scouring pads and hand cleaners.

ABRASIVE PADS - There are three basic types. Metal pads are a mesh from fine #00 to #3 grade. Stainless steel pads are similar to metal but generally coarser and the stainless steel will not rust. Carbon silicate pads are coated over nylon, polyester or other materials.

ABSORBENT - A material that attracts substances from a surface to the absorbent material. Widely used in carpet cleaning and concrete cleaning.

ABSORPTION - The passage of a material through the skin.

ACCESSORIES - Various tools that may be used in conjunction with cleaning machines and equipment; i.e. a dusting tool with a wet and dry vacuum.

ACID - A water soluble substance with pH less than 7 that reacts with and neutralizes an alkali.

ACRYLIC - Type of polymer popular for floor finishes. Also, a man made synthetic fiber used in spun yarn to resemble wool in carpet.

ACRYLIC STYRENE - Popular type of polymer blend for floor finishes.

ACUTE EFFECT - An adverse effect that develops rapidly from a short term high level exposure to a material.

ADHESION - A necessary component of a floor finish, which causes it to stick to the floor rather than peel, flake or powder.

AEROBE - A microorganism that requires air (oxygen for growth).

AEROSOL - An extremely fine mist or fog consisting of solid or liquid particles suspended in air. Also, term used for products which mechanically produce such a mist.

ALCOHOL - A class of organic compounds containing one or more hydroxyl groups (OH). Alcohol is used in detergent formulations to control viscosity, to act as a solvent for other ingredients and to provide resistance to low and freezing temperatures encountered in shipping, storage and use.

ALGAE - Microscopic single cell plants that grow in water, contain chlorophyll and require sunlight.

ALGAECIDE - Product which destroys algae.

ALGISTAT - Product used to inhibit algae growth.

ALKALI - A chemical substance with pH greater than 7 that reacts with and neutralizes an acid. Also called alkaline or base.

ALKALINITY - Alkalinity is useful in removing acidic, fatty and oily soils. Soap and soap-based products are alkaline and perform well only in an alkaline medium. Detergent products can be formulated at any level of alkalinity determined by the cleaning task to be performed.

ALLERGIC REACTION - An abnormal physiological reaction to chemical or other stimulus.

ALL PURPOSE CLEANER - A powder or liquid detergent suitable for both general house cleaning duties and laundry. These products may not be as effective for specific cleaning jobs as products specially formulated for the task.

AMERICAN ORIENTAL - Woven American carpets of Axminister or Wilton weave in oriental colors and patterns.

AMINE - A class of organic compounds containing nitrogen. Amines are often used as floor finish strippers, buffering agents in liquid laundry detergents and as fabric softeners.

AMMONIA - An alkaline gas composed of nitrogen and hydrogen (NH_3), 5% to 10% solutions of ammonia are sold as household ammonia. Ammonia is used to aid in removing grease and dirt from surfaces and to boost the cleaning power in grease cutters, wax strippers and general purpose soil removers.

ANAEROBIC BACTERIA - Bacteria that thrives in the absence of air or oxygen.

ANHYDROUS - The active soap content of liquid soap.

ANIONIC - Negatively charged part of a molecule. Anionic surfactants are widely used in high-sudsing detergents.

This glossary is reprinted with permission from the *Official ISSA Dictionary of Cleaning Industry Terms*, copyright 1990 by the International Sanitary Supply Association, Lincolnwood, Illinois.

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ANTIDOTE - An agent that neutralizes or counteracts the harmful effects of poison.

ANTIMICROBIAL - Agent which inhibits or destroys bacteria, fungi, protozoa or viruses that are pathogenic.

ANTISTATIC AGENT - A substance that reduces static electricity by preventing friction. Friction causes fabric (especially man-made fabrics such as nylon and polyester) to produce static electricity discharge.

ANTISEPTIC - A chemical agent that prevents or inhibits the growth of microorganism microbes, particularly on the skin.

ANTISTAT - Substance which reduces static electricity.

A.O.A.C. METHOD - Association of Official Agricultural Chemists' method of determining phenol coefficient and kill-effectiveness of disinfectant and sanitizing products.

ASEPSIS - Refers to the absence of pathogenic microorganisms.

ASPHALT TILE - A floor tile manufactured with a mixture of synthetic fibers, lime rock, mineral fillers and coloring. Asphalt is used to bind the materials together.

ASPHYXIANT - A vapor or gas which can cause unconsciousness or death by suffocation. A potential hazard, particularly when working with certain chemicals in unventilated or confined areas.

AUTOCLAVE - A steam and disinfectant method for sterilization in hospitals.

AUTOIGNITION TEMPERATURE - The lowest temperature at which a flammable gas will spontaneously ignite without a spark or flame.

AUTOMATIC SCRUBBER - Labor-saving powered floor cleaning machine that dispenses cleaning solution to the floor, scrubs it and vacuums it up into a recovery tank.

AXMINISTER - A carpet weave in which pile tufts are individually inserted from colored yarns arranged on spools, making possible an enormous variety of colors and patterns.

B

BACILLI - Cylindrical or rod-shaped bacteria.

BACKING - The various materials that comprise the back of a carpet that secures the face of carpet pile. They include Primary backing which is frequently a woven or non-woven polypropylene, a woven jute or on scatter rugs cotton duck. Secondary backing which is fabric (usually jute, woven or nonwoven polypropylene) laminated to the back of carpet to reinforce and increase dimensional stability. Construction yarns comprising chain warp, stuffer warp, and shot fill which are interwoven with the face yarn during carpet formation, are the backings of woven carpets.

BACTERIA - Single cell microorganisms not containing chlorophyll. Germs.

BACTERICIDE - A chemical agent that destroys bacteria.

BACTERIOSTAT - A chemical agent that prevents bacteria from multiplying and growing (doesn't kill).

BASE (SEE ALKALI) - A water-soluble substance with pH greater than 7.

BASE UNIT - The main power source for a "steam" type carpet cleaner.

BEATER BAR - A rigid bar on a vacuum cleaner brush that agitates and loosens soil from the carpet.

BIODEGRADABLE - Capability of organic matter to be decomposed by biological processes.

BIRD'S EYES - Circular blemishes on a polymer or wax surface caused by bubbles solidifying during application. Usually caused by agitation of the floor finish during the application or by applying heavy coats of finish. Also known as "fish eyes."

BLEACH - A product that cleans, whitens, removes stains and brightens fabrics. It also removes stains on some hard surfaces.

BLEEDING - Removal of color from carpet or other floor tile material by a liquid. Some carpets may bleed with hot water. Floor tile (particularly asphalt) can bleed from an excessive concentration of stripper solution.

BLOOMING - A white deposit on the surface of a new concrete or magnesite floor. Is either soluble salt or magnesium chloride.

BOILING POINT - The lowest temperature at which a liquid becomes a vapor.

BRIGHTENERS - Optical or fluorescent enhancers found in carpet cleaning products and fabric cleaners.

BRIGHTWORK - The chrome plumbing fixtures around sinks, fountains and the tops of toilets and urinals.

BROADLOOM - Term of measurement that designates the width of a carpet.

BROAD SPECTRUM - Killing a wide variety of Gram - (Negative) and Gram + (Positive) organisms.

BROWNING (BROWN OUT) - A reaction that occurs in carpets when high pH solutions cause the carpet's natural coloring in the backing (usually jute) to travel up the fiber strand and discolor the carpet. Easily cured with debrowning product applications.

BUCKLES - Deviations in a carpet where it does not lay flat; wrinkles.

BUFFER - Any substance in a fluid which tends to resist a change in pH when acid or alkali is added. Also a slang term for a floor buffing and scrubbing machine.

BUFFING - Polishing with a floor machine, floor pad or brush.

BUILDER - A material that enhances and maintains the cleaning efficiency of the surfactant. Used to improve cleaning performance.

BUILT DETERGENT - A cleaning product containing both surfactant and builder.

BURNISH - To buff a floor finish before it dries or at high speeds to develop a hard shine.

BUTYL CELLUSOLVE - A trademark name for a water-soluble solvent frequently used in degreasing products. Actual name of slang term "butyl".

BYPASS MOTOR - A wet/dry vacuum motor that employs two sources of air in the machine's operation; i.e, working or vacuum air and cooling air.

C

C.F.M. - Cubic Feet per Minute. Describes the amount of air generated by a vacuum motor.

CALCIUM CARBONATE - An insoluble compound that occurs naturally as chalk and limestone that results from the reaction of sodium carbonate and the hard water ion.

CARNUBA - Natural polishing wax which is derived from the leaves of the carnuba palm tree in Brazil. Average yield per year from one tree is approximately four to five ounces of wax.

CARPET CUSHION - A term used to describe any kind of material placed under a carpet to provide softness when it is walked upon. Also called lining, padding and underlay.

CARPET FRESHENER - A product designed to counteract malodor in carpets.

CARPET SQUARES (TILES) - Loose-laid or self-adhesive backed squares of carpet.

CARRIER - A person in apparent good health who carries a pathogenic microorganism (germ).

CASTILE - Originally soap made from olive oil in Castile, Spain. Now refers to any mild soap made from vegetable oils.

CATALYST - A substance which influences a chemical action.

CATIONIC SURFACTANT - A surfactant that is from a positively charged ionic group. The most common cationic surfactants are known as quaternary ammonium compounds such as alkyl dimethyl benzyl ammonium chloride. These are widely used as disinfectant and sanitizing products.

CAUSTIC - Strong base (alkaline) substance which irritates the skin. Corrosive. When the term is used alone it usually refers to caustic soda (sodium hydroxide), which is used in manufacturing hard soap. It also refers to caustic potash (potassium hydroxide), which is used in manufacturing soft soap.

CERAMIC TILE - Clay tile with an impervious, usually glossy layer on the surface.

CHELATING AGENT - An organic sequestering agent used to inactivate hard water and other metallic ions in water.

CHLORINE - Powerful oxidizing agent sometimes used as a germicide.

CHLORINE BLEACH - A group of strong oxidizing agents commonly sold in an approximately 5 % solution of sodium hypochlorite. As a laundry additive, liquid chlorine removes stains, aids in soil removal, whitens, disinfects, and deodorizes. Dry forms of chlorine bleach are frequently used in cleansers and automatic dishwasher detergents. Bleach should not be used with silk, woolens, dyes sensitive to hypochlorite, and on certain stains such as rust (which it can set). Chlorine bleach deactivates enzymes in laundry cleaners.

CHRONIC TOXICITY - Adverse affects caused by continuous or repeated exposure to a harmful organism over a period of time equal to 1/2 of the organism's lifetime.

CIDAL OR "CIDE" - Generally refers to agents with the ability to kill microorganisms.

CLEANED-IN-PLACE (CIP) - The cleaning and sanitizing of food and dairy processing equipment in its assembled condition by circulation of detergent, rinse, and sanitizing solutions under appropriate conditions of time, temperature, and physical action.

CLEANING HEAD - A tool used in carpet extraction cleaning, which sprays solution and vacuums it up.

CLEANSER - A powdered or liquid cleaning product generally containing abrasives, a surfactant and frequently a bleach.

COCCI - Spherically shaped bacteria.

COLONY - A visible growth of microorganisms on a culture medium.

COMMUNICABLE DISEASE - One whose causative agent is directly or indirectly transmitted from person to person.

CONCENTRATE - The undiluted form of a dilutable cleaning product.

CONDUCTIVE FLOORS - Special resilient tile that is designed to drain off or prevent static electricity. Frequently used in computer rooms.

CONTAMINATION - Entry of undesirable organisms into some material or object.

CONTINUOUS FILAMENT - Continuous strand of synthetic fiber extruded in yarn form, without the need for spinning which all natural fibers require.

CORROSION - Process of gradual eating away by chemical action.

CORROSION INHIBITOR - Substance which protects against oxidation of metal surfaces.

CORROSIVES - Substances which cause skin and eye damage at the site of contact.

CROSS-CONTAMINATION - The process of transferring bacteria from one person or an object to another person. Similar term to cross-infection.

CURING - A chemical aging process that allows floor finishes to bond to a floor surface.

CUT PILE - The face of a carpet that has had the ends cut at the loops.

D

DAMP MOPPING - Mopping with a mop wrung out tightly in a clean solution containing mild detergent, disinfectant or sanitizing agent.

DEFOAMER - Substance used to reduce or eliminate foam.

DEGRADE - The loss of strength in bleach solutions caused by time and action of sunlight.

DEGREASER - A product specifically formulated to remove grease, oil and greasy soils.

DEODORANT - A product for destroying, masking or eliminating offensive odors.

DETERGENCY - Cleaning efficiency.

DETERGENT - Synthetic cleaning agent (other than soap) which is useful in physical removal of soils.

DIGESTER - An enzyme used to break down stains caused by food products and blood.

DIMENSIONAL STABILITY - The tendency of a fabric to retain size and shape. A carpet receives additional dimensional stability from the secondary backing.

DISINFECTANT - An agent that destroys harmful bacteria and/or viruses on inanimate surfaces (except spores). Most common types include Quaternary Ammonium Compounds, Phenolic Compounds, Pine Oil (at least 70%). Products making disinfectant claims must be registered with the Environmental Protection Agency (EPA), and state it on the label with a registered EPA number.

DOUBLE BUCKET PROCEDURE - A mopping technique that utilizes two buckets. The first bucket contains a disinfectant and the other, clear rinse water. The mop goes from the disinfectant to the floor, from the floor to the clear water rinse, to the wringer and back into the disinfectant. The procedure reduces disinfectant contamination.

DRAIN CLEANER - A chemically strong product formulated to clean plugs of solid grease and other varied materials embedded in drains.

DRY FOAM - A detergent solution with a small amount of water that is mechanically worked into a carpet. The loose soil is removed by a vacuum.

DRY ROT - A condition caused by an attack of microorganisms on fibers, textiles, carpets and other materials. An attack on natural carpet backing may cause loss of strength that leads to tearing and breaking up.

DUSTING PRODUCT (FURNITURE) - An aerosol or pump spray that dispenses ingredients in a fine spray onto surface of dusting cloth. Some cloths come already impregnated with active ingredients. These products attract, pick up and retain light dust and soil.

E

ECONOMIC POISON - Pesticide.

EMOLLIENT - An ingredient for making skin soft or soothed.

EMULSIFICATION - The action of breaking up fats, oils and other soils into small particles which are then suspended in a solution.

EMULSION - A dispersion of small oil particles in a solution.

ENVIRONMENTAL IMPACT - The possible adverse effect of the release of a material into the environment as listed in MSDS information.

ENZYME - Protein molecules produced within an organism that are used as catalysts for biochemical reactions. Often used to enhance cleaning products.

E.P.A. - Environmental Protection Agency of the United States Government. Has responsibility to regulate the environment.

EPIDEMIC - A condition in which a large number of persons in a community contract the same disease within a short time.

EPOXY - A very hard synthetic resin often used in floor finishes, paints and sealers.

ETCH - A chemically caused change on the outside of a smooth floor surface which causes the floor to be pitted or rough, and thereby improve adhesion of floor finish.

EXPLOSION HAZARD - Hazard of some materials when they are exposed to heat or flame.

EXPOSURE LIMIT - The limit set to minimize an employee's exposure to a hazardous material. Associated terms include Permissible Exposure Limit (PEL), Short Term Exposure Limit (STEL) and Threshold Limit Value (TLV).

F

FADING - Loss of color caused by actinic radiation such as sunlight, atmospheric gasses and cleaning or bleaching chemicals.

FASTNESS - Retention of color by carpets and other materials.

FATTY ACID - An organic (most commonly tallow and coconut oil) substance which reacts with a base to form soap.

FIBERS - Natural or man-made objects that have lengths hundreds to thousands of times greater than their widths (high aspects ratio).

FILAMENT - A single continuous strand of fiber.

FILMING - The development of a thin covering or coating.

FISH ACUTE TOXICITY TEST (LC5O,96 hours) - Test used to define toxicity and hazard potential to fish. Results reported as LC50, i.e., the concentration which will kill 50% of the fish.

FISH EYES - See "Bird's Eyes."

FLAGGED FIBERS - Brush or broom fibers that are split at the end to increase cleaning efficiency.

FLAMMABILITY - The capacity of a material to ignite easily and burn rapidly. This term is also used to classify certain liquids on the basis of their flash point.

FLASH POINT - The lowest temperature at which the vapor from a product will ignite.

FLOOR MACHINE - (Buffer) A powered machine used to scrub and buff floors that is equipped with a pad driver and synthetic pads or a brush.

FLOOR FINISH - The top layer of protective floor coatings.

FOAM - A mass of bubbles formed on liquids by agitation.

FOMITE - Any object or substance, other than food, that harbors or carries infectious organisms.

FORMALDEHYDE - Preservative; sterilizing and disinfecting agent (gas or liquid).

FUNGI (FUNGUS) - Vegetable organisms that lack chlorophyll and are filamentous. Fungus includes mold, mildew, yeast and mushrooms.

FUNGICIDE - A chemical agent that destroys fungi.

FUNGISTAT - Chemical which inhibits the growth of fungi.

FURNITURE CLEANER/POLISH - A liquid, paste or aerosol spray designed to remove dust and stains from wood surfaces, confer shine and protection against water spots, and is formulated to reduce wax buildup with continued use.

FUZZING - A loose, hairy effect on a fabric surface caused by wild fibers or slack yarn twists. May be corrected by professional cleaning.

G

GAGE (GAUGE) - The distance expressed in fractions of an inch between two needle points in carpet knitting or tufting.

GEL - A colloid in a semi-solid state, having a "jelly"-like consistency.

GERMICIDE - Any substance that kills germs. A disinfectant.

GLUTERALDEHYDE - A chemical relative of formaldehyde, used in cold sterilization.

GRAINS HARDNESS - A measure of water hardness. The actual amount of dissolved calcium and magnesium salts measured in parts per million in a gallon of water.

GRAM POSITIVE AND GRAM NEGATIVE - Classification of bacteria by their reaction to staining. A dye is applied to bacteria, and those that remain permanently stained are Gram positive. If the stain is easily removed they are Gram negative. Staph and strep are examples of Gram positive bacteria. Psudomonas and salmonella are examples of Gram negative bacteria.

GROUT - Matrix between ceramic tile on walls and floors.

H

HALOGENS - The elements chlorine, bromine, iodine, fluorine, which have strong disinfecting properties.

HAND CLEANER - A cleaner designed to clean hands with an emphasis on removing oils, grease and other occupational soils.

HARD WATER - Water containing soluble salts of calcium and magnesium and sometimes iron.

HAZARDOUS MATERIAL - Any substance having the properties capable of producing adverse effects on the health or safety of people.

HEELING - Technique of applying pressure to the side of a floor machine to remove black shoe marks and persistent soil.

HEXACHLOROPHENE - One of the synthetic phenol compounds currently used in prescription antiseptic soaps.

HIGH SPEED FLOOR MACHINE - Any floor buffing or burnishing machine that operates at RPMs over 200.

HIGH SPEED FLOOR FINISH - Floor finish specifically designed to be used with and respond to a high-speed floor machine.

HOLIDAY - A missed spot in cleaning. Refers to streaks or areas that were not overlapped.

HOSPITAL-TYPE DISINFECTANT - Kills most germs due to a special combination of disinfectant ingredients. More terminology than fact.

HYDROCHLORIC ACID (HCL) - Also known as muriatic acid. Used in toilet bowl cleaners in varying dilutions. Hydrogen Chloride.

HYDROFLUORIC ACID (HF) - A highly caustic inorganic acid often found in commercial rust removers and stain removers. Use with extreme caution.

HYPOCHLORITE - A powerful disinfectant containing chlorine.

I

ID5O - The dose (number of microorganisms) which will infect 50 percent of the experimental animals in a test series.

IMPERVIOUS - Incapable of being penetrated by a given material.

INCOMPATIBLE - Substances which cause adverse reactions from contact with each other.

INCUBATION - Maintaining cultures of microorganisms at a temperature favorable to their growth.

INERT - Substance not active in a formula.

INFECTION - A condition in which microorganisms have entered the body and produced an adverse reaction.

INGESTION - Taking a substance into the body by mouth.

INHALATION - Taking a substance into the body by breathing.

INHIBIT - Bacteriostatic action slows down or restricts the growth of bacteria rather than killing the bacteria.

INHIBITOR - A chemical or substance used to slow down or restrain an undesirable reaction such as corrosion.

INORGANIC - A substance not made of the combination of carbon and hydrogen.

IODINE - A disinfectant agent.

IODOPHOR - Combinations of iodine and detergent used in antisepsis or disinfection.

IONIC COMPATIBILITY - Electrical charges in chemical formulations similar to the North, South poles on a magnet. The charges indicate to the formulating chemist the compatibility of various ionic or non-ionic chemical products. Blending or cross use of chemical products that do not possess compatible ions will render the products useless for their intended purpose.

IRRITANT - Something that causes an inflammation reaction in the eyes, skin, or respiratory system.

J

JUTE - A natural cellulosic fiber made from certain plants of the linden family which grow in warm climates such as India and Bangladesh. Jute yarns are used in woven carpet construction as backing for the yarns and twines. Woven jute is used in tufted carpet as primary and secondary backing. The latter are similar to burlap fabrics.

K

KNITTING - A fabric formation process comprising interlacing yarns in a series of connected loops with needles. Pile and backing are produced simultaneously with multiple sets of needles that interlace pile backing and stitching. A small fraction of total carpet production is produced by knitting.

L

L.D. POINT - Abbreviation for "Lethal Dose."

LD50 - The dose (number of organisms) that will kill 50 percent of the animals in a test series.

LATEX - A water emulsion of synthetic rubber, natural rubber or other polymer used in carpet manufacturing, to laminate the secondary backing to tufted carpeting, backcoating carpet and rugs.

LATHER - A foam consisting of very small bubbles formed when soap or detergent is agitated with or in water.

LETHAL CONCENTRATION (LC) - The concentration required to cause death in a given species of animal or plant. Measured in milligram per kilogram of body weight (mg/KG).

LETHAL DOSE (LD) - The dosage required to cause death in a given species of animal or plant. Measured milligram per kilogram of body weight (mg/KG).

LEVELING AGENT - Substance added to coating wh allows it to flow evenly in application and to help prevent "puddling".

LEVEL LOOP - A carpet style having all tufts in a loop form and of identical height.

LIME - An insoluble mineral deposit found in water.

LINOLEUM - A flooring material composed of binders, oxidized oil and resinous material that is mixed with ground cork or wood flour and pigment. The composition is applied to a backing of felt, fabric or burlap.

LOOM - A machine which produces woven fabrics.

LOOP PILE - Carpet style having a pile surface consisting of uncut loops of woven or tufted yarn. Also called "round wire" in woven carpet terminology.

LUDOX - Sand-like material added to wax to increase slip resistance.

M

MEDICATED SOAP - A toilet soap containing antibacterial ingredient to help reduce or inhibit the growth of bacteria on the skin, which might otherwise cause infection.

METAL INTERLOCK - Detergent- and water-resistant type of floor finish with a metal salt in the solution. Removable with ammonia strippers.

MICRON - 1/25,000 of an inch.

MICROORGANISMS - Plants or animals visible only with the aid of a microscope.

MILDEW - A growth, usually white, produced by fungus.

MILK STONE - Calcium deposits on dairy or ice cream equipment.

MILLED SOAP - Soap processed by an operation in which soap chips or pellets are squeezed and kneaded by passing them through a series of heavy, closely set rollers.

MOLD - A woolly growth, produced by fungus.

MOLECULE - The smallest unit into which a substance can be divided that retains all of the chemical identity of that substance; i.e., one molecule of water.

MONTAN WAX - Mineral wax extracted from lignite or peat (brown coal). It is a hard polishing wax.

MURIATIC - Commercial name given to hydrochloric acid.

MUTAGENIC - Causes tissue changes in subsequent generations.

N

NEUTRAL - A chemical state that is neither acid or alkali (base); 7 on the pH scale.

NEUTRAL CLEANER - Non-alkaline, non-acid cleaner. The pH of mild neutral cleaners may be as high as 10 and not contain harsh alkalis.

NEUTRALIZER - Chemical to change the pH of a surface so that residues will not interfere with floor coating adhesion.

NON-CHLORINE BLEACH - A laundry product containing peroxygen compounds, which release active oxygen in wash water. This type product produces gentler bleaching action than chlorine bleach.

NON-IONIC SURFACTANT - A surface-active agent that contains neither positively nor negatively charged (ionic) functional groups. These surfactants have been found to be especially effective in removing oily soil.

NON-SELECTIVE - A term applied to disinfectants that kill a wide variety of organisms including bacteria and fungi.

NON-WOVEN - Any fabric manufactured by a method other than weaving.

NYLON - Synthetic thermoplastic of the polyamide family. It is the dominant fiber in tufted carpet pile yarns.

O

OLEFIN - Any long chain synthetic polymer composed of at least 85% by weight of ethylene, propylene or other olefin units. It is used in the manufacture of carpets and matting.

ONCOGENIC - Produces or induces tumor formations in living animals.

OPACIFIER - Substance which does not permit the transmission of light; a cloudy agent. It is used to reduce a soap's translucence or to make a bar of soap white or a desired color.

OPTICAL BRIGHTENER - Substance which makes color appear brighter in the presence of sunlight and ultraviolet light.

ORIENTAL RUGS - Handwoven rugs made in the Middle East and the Orient.

ORGANIC - A substance composed of carbon and hydrogen.

ORGANISM - Any individual animal, plant or bacterium.

OSHA - Occupational Safety and Health Agency which establishes and enforces laws relating to worker safety.

OUTDOOR CARPET - Carpet specifically designed to resist fading and deterioration due to sunlight and water. Most are solvent-dyed polypropylene containing ultraviolet stabilization additives. Coatings and backings that are water and rot resistant are usually synthetic.

OVEN CLEANER - Usually a liquid in an aerosol container or pump-actuated bottle. To clean a cold oven a strong chemical is necessary. Usually the product is thick or foamy to promote clinging to vertical surfaces.

OXIDATION - To combine with oxygen. Slow oxidation is typified by the rusting of a metal.

OXIDIZED - Bleached

P

PASTE WAX - Wax in a thick form. Always needs buffing.

PATHOGEN - Any disease-producing organism.

PATHOGENIC - Disease-producing.

PESTICIDE - Agent which prevents, repels, destroys or mitigates pests types include insecticides, disinfectants and sanitizers, rodenticides and herbicides.

pH - A simple chemical scale which expresses the degree of acidity or alkalinity of a solution. The pH scale runs from 0 to 14. 7 is the neutral point. Numbers below 7 indicate acidity with 0 being 10 times more acidic than 1, 1 being 10 times more acidic than 2, etc. 0-3 is strongly acidic,4-6 moderately acidic. Above 7 is the alkaline side. 8- 10 is moderately alkaline, 11- 14 is strongly alkaline. Alkalinity is 10 times greater at each full number rise along the scale.

PHENOL COEFFICIENT - A comparison of germicidal effectiveness of disinfectant products with phenol. Usually considered an obsolete comparison.

PHENOL - Chemical used for disinfecting (phenolic disinfectant). Also known as carbolic acid.

PHOSPHATE - A widely used water softener, builder and sequestering agent used in detergents.

PHOSPHORIC ACID - The most common acid based on phosphorus sometimes called orthophosphoric acid. Used as a mild bowl acid and in formulations of light duty detergents.

PILE CRUSH - Loss of pile thickness in a carpet due to traffic and heavy furniture. The tufts collapse into the air space between them.

PILE HEIGHT - The length of the extended tufts of a carpet, measured from the primary backing top surface to their tips.

PILE LIFTER - A machine that loosens soil, vacuums it and stands the pile up prior to deep cleaning.

PILE DENSITY - Refers to closeness of fibers in a carpet to each other. High density increases weight and quality.

PILE SETTING - A carpet cleaner's term for the process of erecting damp, disheveled pile following shampooing or extracting, through the use of a pile brush or pile lifting machine.

PINE OIL - An oil processed from the gum of pine trees. Used in hard surface cleaning and disinfecting and distinguished by a characteristic aroma. As a disinfectant it is inactive against staphylococci.

PINE OIL CLEANER - A liquid hard surface cleaner containing detergents and pine oil. Used to dissolve oil, fatty acids, paints and tars while disinfecting/sanitizing and deodorizing with a pine odor.

PITTING - Small craters on the surface of concrete and terrazzo floors which will grow in size, with traffic and chemical exposure, unless coated with a protective floor finish.

PLASTICIZER - An ingredient added to wax, varnish, and polymer floor finish to make it flexible rather than brittle.

PLY - The number of single strands of fiber which have been twisted together to form a yarn; i.e., 3 ply, 4 ply.

POLYESTER - A fiber-forming thermoplastic synthetic polymer used in some carpet that is essentially staple and spun yarn.

POLYPROPYLENE - Synthetic thermoplastic polymer that is used for carpet fiber which is solution dyed and usually contains ultraviolet stabilizers for outdoor use.

POLYMER - A large molecule of multiple units formed into a single building block linked together. The formation of multiple units of these molecules is called polymerization. Common types of polymers include styrene, acrylic, polyethylene, urethane, bakelite, vinyl, and epoxy.

POLYMER EMULSIONS - Polymer materials that are chemically emulsified into a water base. When these formulations are applied to surfaces they form a smooth, continuous finish.

PORCELAIN ENAMEL- - A coating of ceramic type material that is fired or fused to a steel base and used in sinks, bathtubs, etc. This differs from the vitreous china used in toilets and urinals.

POWDER - A carpet cleaning preparation consisting of absorbent granules impregnated with dry cleaning fluids, detergents and other cleaners. The powder is sprinkled on the carpet, worked into the pile with a brush and left to absorb soil for a short time, and finally removed with the absorbed soil by vacuuming.

POWDERING - An unfortunate condition of polymer-type floor finish being removed from a floor in the form of fine, white dust. Usually caused by abrasion occurring from buffing, heavy traffic and inclement weather.

PPB—Parts per billion. One part per billion equals 1 pound in 500,000 tons.

PPM—Parts per million. One part per million equals 1 pound in 500 tons.

PRECAUTIONARY STATEMENT - Warnings on product labels to alert users to potential harmful hazards associated with using the product.

PRECIPITATE - Material settled out of solution.

PRESERVATIVE - A chemical agent that inhibits aging

such as decay, discoloration, oxidation and microbial growth.

PRESOAK - A soaking operation, to remove stains, that precedes the regular laundering process.

PRE-SPOT - Removal of stains before more extensive carpet cleaning.

PRIMARY BACKING - The carrier fabric for the pile yarn of a carpet into which the yarn tufts have been inserted.

PROPELLANT - An agent used to expel contents from an aerosol under pressure.

PSEUDOMONAS AERUGINOSA - A pathogenic bacteria used to assess hospital-strength activity of a disinfectant.

PUMICE - Porous volcanic rock frequently used as an abrasive.

Q

QUATERNARY AMMONIUM COMPOUNDS - A class of chemicals used as disinfectant, antistat and softening agents (Quats).

R

RE-EMULSIFICATION - A chemical process that occurs when a film of floor finish has not completely dried and is re-liquified by a subsequent application of finish. It doesn't appear until the floor has dried and then appears streaked or dull.

REFINISHING - To apply a new coat of wax or floor finish to a floor.

RESIDUE - Cleaning chemicals or soil left in a carpet after the cleaning process.

RESILIENT TILE - Tile that will withstand shock without permanent damage; includes rubber, cork, asphalt, linoleum, vinyl, vinyl asbestos. This tile will give under impact and certain loads and then return to its' original form after the load is removed.

RESINS - The basic solid content of gym and concrete floor finishes that are solvent-borne.

RINSE AGENT - A wetting agent used in the last rinse during dishwashing to improve the draining of the water from dishes and utensils.

RINSE AIDS - Surfactants which aid in the rinsing property of water by lowering its surface tension.

ROTARY BRUSH CARPET CLEANING - A carpet cleaning technique in which a detergent solution is worked into the carpet pile by a brush attached to a rotary buffing machine. Loosened soil is usually removed by vacuuming.

RUST REMOVER - A specialty cleaner used to remove rust stains from carpet yarn.

S

SANITIZER - An agent that reduces the number of bacteria to a safe level, but does not completely eliminate them, as judged by public health requirements. Usually in food service areas.

SAPONIFICATION - The process of converting a fat into soap by treating it with an alkali. Also the process used by some cleaners to remove grease and oil.

SCALE - Calcium or mineral deposits in steam boilers and in steam and water pipes.

SCOURING PAD - A hand-sized pad that supplies the cleaning action of an abrasive.

SCRUB - The use of a brush or synthetic floor cleaning pad and detergent solution to clean a floor without removing the floor finish.

SEALER - A coating designed to penetrate and provide the initial protection to a floor surface by filling in the tiny holes. Also, a product which prevents color bleeding.

SECONDARY BACKING - The fabric reinforcement that is laminated to the back or bottom of a tufted carpet to provide strength and stability.

SEPSIS - Poisoning due to absorption of pathogenic bacteria into the bloodstream.

SEPTICEMIA - Condition in which bacteria in the blood have multiplied. (Referred to as "blood poisoning".)

SEQUESTERING AGENTS - Chemicals that tie up water hardness and prevent the precipitation of hard water salts. This action causes clarity in liquid soap.

SHELF LIFE - The time between manufacturing and the time that a product becomes spoiled, unusable or ineffective because of age.

SIZING - A product that provides a coating such as starch.

SLIMICIDE - Prevents or inhibits the growth of biological slimes which contain combinations of algae, bacteria or fungi.

SLIP COEFFICIENT - A measurement of the angle of the point at which a person's foot begins to slip on the James machine (an instrument used to test the static coefficient of friction of a surface). U.L. considers 0.5 or above is the safe limit.

SLURRY - A temporary suspension of insoluble solid or immiscible liquids in a carrier base. Usually refers to the suspension of dirt or the thick, dark, soapy mixture created when stripping a floor.

SOAP - A natural cleaning agent produced by the reaction of a fat or oil and an alkali.

SODA ASH - Sodium carbonate.

SODIUM BICARBONATE - Baking Soda.

SODIUM HYPOCHLORITE - Bleaching and disinfecting agent.

SOIL RESISTANCE - A condition of the floor that occurs due to the application of protective coatings. A finished floor will remain cleaner than an unfinished floor exposed to the same traffic and soil. Finishes are applied to be resistant to dirt, oil, grease, soap, alkalis, acids, bleaches, solvents, and boiling water.

SOIL RETARDANT - A chemical finish applied to carpet and fabric surfaces, which inhibits attachment to the soil fiber.

SOLID CONTENT - The amount of ingredients in a floor finish that do not evaporate or volatilize at 105 C.

SOLUBILITY - The tendency of a material to dissolve in

another material.

SOLUTION - A uniformly dispersed mixture of two or more fluids.

SOLVENT FINISH - Finish in which the solid content is borne in solvent, rather than water.

SOLVENTS - Substances used to solubilize other materials.

SPALLING - The process of concrete or terrazzo breaking apart into dust and pieces.

SPORE - A special hard shell-like cell structure of a rod shaped bacteria which has an inactive form, and is the most resistant of all living things to heat, chemicals and drying. Can only be destroyed by sterilization.

SPOTTER - A carpet stain remover.

SPRAY BUFF - An intermediate floor care procedure which cleans, removes black marks and shines the wear areas of a floor. Utilizes a sprayed solution, a floor machine and a synthetic floor pad.

STAIN - A visible discoloration.

STAIN REPELLENT - A product applied to carpets that helps the yarn resist stains.

STAPHYLOCOCCUS (STAPH) - Highly resistant Gram + (Positive) organism used in the evaluation of disinfectants. Is pathogenic.

"STAT" - Inhibitor.

STERILIZATION - The process of killing all forms of microbial life, including vegetative bacteria, fungi, viruses and spores.

STREAKING - Signs of improper application of floor finish. Generally lines or ridges in rows of uneven floor finish.

STREPTOCOCCUS (STREP) - Common disease organism that microscopically appears as Gram + (Positive) chains.

STRIPPER - Specially formulated detergent which breaks the bond of floor wax and finish, when used as directed, without damaging flooring material.

SURFACE TENSION - The attractive forces which water molecules have for each other.

SURFACTANT - Surface-active agent which increases the emulsifying, foaming, dispersing, spreading and wetting properties of a product.

SUSPENSION - The process of a cleaning agent holding insoluble dirt particles in the cleaning solution and keeping them from redepositing on a clean floor.

SYNERGISTIC - Chemicals that when combined have a greater effect than the sum of the two independently.

SYNTHETIC DETERGENT - A washing or cleaning product that utilizes synthetic surfactants rather than traditional soaps.

SYNTHETIC FIBERS - Man-made fibers, as opposed to natural fibers such as wool, that are used in most carpets today.

T

TACKINESS - A sticky or adhesive condition that is a property of applied floor finishes, when not completely dried.

TACK RAG - A cloth, dampened in solution, that is used to remove surface particles (lint, dust, floor pad abrasive) prior to refinishing a surface.

TELESCOPE HANDLE - An adjustable length pole that extends by pulling tubes out, one inside the other.

TERRAZZO - A non-resilient floor material composed of marble and Portland cement.

TOXIC - Substance causing adverse effects in the body like a poison.

TOXIN - Poisonous substance produced by bacterial cells.

TUBERCULIN - An extract of the tubercle bacillus, capable of eliciting an inflammatory reaction in the animal body which has been sensitized by the presence of living or dead tubercle bacilli. Used in a skin test for tuberculosis.

TUCKER POLE - Special multi-story outside window-washing tool.

TRAFFIC LANE - High traffic areas that show worn or soiled "lanes."

TRAFFIC LANE CLEANER - A heavy detergent compound used to clean high traffic carpet areas.

TRI-SODIUM PHOSPHATE (TSP) - A water softener sometimes used as a cleaning agent.

TURKISH TOWEL - Towel similar to terry cloth.

U

U.L. - Underwriters Laboratories. An organization that tests manufactured products for safety.

U.S.D.A. - United States Department of Agriculture, which approves disinfectants and sanitizers.

URETHANE - A synthetic resin, ethyl carbamate, used in protective coatings for wood, concrete and metal.

USE-DILUTION - The final concentration at which a product is used.

USE-DILUTION TEST - Test used to determine antimicrobial activity of a hard surface disinfectant in its final use concentration.

V

VEGETATIVE BACTERIA - Those able to multiply; the term is used to exclude spores.

VINYL ASBESTOS TILE (VAT) - Floor tile composed of vinyl resin, plasticizers, asbestos fibers, mineral fillers and color pigment formed into a given thickness and cut into tile sizes.

VIRUS - A group of filterable infective agents that require the presence of living cells in order to multiply.

VIRUCIDE - A chemical agent that kills viruses.

VIRULENCE - The disease-producing ability of an organism.

VIRUSES - Microorganisms smaller than bacteria which cannot grow outside living cells.

VISCOSITY - The thickness of a liquid which determines pourability. The resistance to flow is measured in relationship to water in centipoise (cp). Water has a viscosity of 1 cp.

VITREOUS CHINA - Ceramic, non-porous material used in toilets and urinals.

VOLATILE - The part of a product that evaporates during drying.

W

WAREWASHING - Washing of dishes, utensils, glassware, pots, pans, etc. in the institutional market.

WATER CONDITIONER - A material that improves the quality of water for a given application or use.

WATERLIFT - An efficiency rating for vacuums used to pick up water. Tells how many inches the water would be raised or "lifted" in a measuring column.

WATER HARDNESS - A measure of the amount of metallic salts found in water. Hard water can inhibit the action of some surfactants and reduce the effectiveness of the cleaning process.

WATER SOFTENER - Substance which removes or counteracts the hardness of water.

WAX - A natural protective coating for hard surfaces.

WEAR - A distortion of the surface of a floor coating due to traffic and abrasion.

WET MOPPING - Applying a liberal amount of cleaning solution. Used in disinfecting, thorough cleaning, scrubbing and stripping. Requires removing excess solution.

WETTING - The ability of a solution to disperse or spread over an oily or otherwise water-repellent surface.

WETTING AGENT - A chemical which reduces surface tension of water, allowing it to spread more freely.

Y

YEAST - A form of fungus.

YELLOWING - Discoloration of a floor finish due to aging. A common complaint regarding carnuba wax.

12 / Maintaining Synthetic Counter Tops and Table Tops

Counter tops and table tops constructed of man-made materials present a special problem for the maintenance staff. Although modern synthetic materials are highly resistant to spills, counters and table tops located in science rooms may be subject to chemicals that can penetrate. Moreover, tops subjected to abrasive cleaners lose their surface resistance and readily absorb stains.

Spills

Counters and table tops in regular use must be continually inspected for spills that might penetrate the surface if left unattended.

- Chemical or acid spills call for extreme caution. See Procedure 3 in Chapter 9.
- Safe spills should be cleaned up immediately with a cellulose sponge and warm sudsy water. Rinse with clean cold water.

Stains

Stains may be removed with a normal strength all-purpose cleaner followed by a clean cold water wash and rinse. If the stain has set and an abrasive cleaner must be used, the surface lacquer may be damaged and require refinishing.

Inspection

Synthetic tops should be inspected at intervals of no more than 200 hours of service. Look for deterioration of the vinyl lacquer seal coat. When the seal coat breaks down, the surface must be refinished or normal spills will produce penetrating stains.

Waxing

Synthetic surfaces should be paste waxed at intervals of no more than 36 hours of normal service. The wax will help protect the surface against spills and stains.

Refinishing

Refinishing becomes necessary when the vinyl lacquer seal coat breaks down from chemical spills, cleaning with abrasive cleansers, or just day-to-day wear without regular waxing. It usually is necessary to refinish an entire top in order to produce a uniform appearance.

1) Begin by washing and rinsing the entire surface.

2) Use an approved solvent or stripping solution to remove whatever lacquer remains on the surface. **Caution:** Most products effective in removing lacquer will present safety considerations and require special handling and disposal. Be sure to follow directions. See the section on Waste Management in Chapter 6.

3) In removing the residual lacquer, use a clean cloth to wipe away softened lacquer and excess cleaner.

4) Use abrasive cleansers to remove stains that have penetrated.

5) Stains that will not respond to cleanser may require sanding. Use an orbital sander with 100 to 120 grit silicon carbide paper. Sand the entire surface unless the operator is skilled at feathering out to the unsanded surfaces.

6) Be sure the surface is completely free of abrasive grit or dust.

7) Coat the surface with vinyl lacquer. The lacquer should be applied at a room temperature of no less than 65 degrees F. Wait at least 24 hours and apply a second coat.

8) When the final coat of lacquer is completely dry, apply paste wax.

Maintaining Synthetic Counter Tops and Table Tops, original chapter and Third Edition review by Keith Middleton, of Middleton and Associates, Normal, IL.

— NOTES —

Section Three

Maintaining the Building

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13 / Exterior Building Care

Timely cleaning and repair of exterior building surfaces and components extend useful building life. As in maintaining all physical plant property, careful scheduling and record keeping are necessary to keep buildings looking well-kept and to avoid damaging deterioration by correcting small problems before they become large ones. Develop check lists for each building to guide inspection procedures. The aim should be to find and record visible defects and to repair them as promptly as possible.

A work schedule should be developed to aid in scheduling and assigning jobs and should be coordinated with the Annual Building Inspection Checklist provided in the Management Tools Appendix.

Following is a typical schedule for exterior building maintenance that should be satisfactory in most instances. Note that this schedule probably should be coordinated with a grounds maintenance schedule (see Section Four—Grounds Maintenance).

Daily

Raise and lower flag.

Weekly

Sweep walks, drives, and parking areas.
Collect litter at building entries, around planters, and on lawns.
Wash door glass and side lights.

Monthly

Wash windows.
Wash aluminum entrance doors.
Inspect building exterior.

Quarterly

Adjust door hardware.
Lubricate door hinges and locks.
Inspect roofing.
Inspect landscaping.

Annually

Lubricate window hinges.
Inspect sidewalks (in late spring).

As needed

Replace light fixture lamps.
Repaint wood trim and sheet metal.
Caulk sash and door frames.
Repaint metal doors and frames.
Remove snow and ice.
Remove debris at storm inlets.
Tuck masonry cracks. (Consider clear silicone sealant for persistent cracks caused by expansion and contraction.)

Personnel assigned to exterior building maintenance should be experienced in at least minor maintenance tasks, such as tuckpointing, painting, caulking, and carpentry. Major repair tasks may be more beneficially handled by outside contractors. Inspection and other non-emergency types of work can be scheduled during student vacations and/or holidays.

While some tasks must be repeated regularly, others need be accomplished only as they become necessary, such as repainting of wood and metal surfaces and caulking. Necessity for such tasks can be determined during quarterly or annual inspections or based upon a predetermined cycle (such as arbitrarily repainting wood trim every three or four years or recaulking sash and door frames every five years).

Inspectors of exterior and interior surfaces should be alert to insect infestation. Termites can severely damage untreated wood sills, casework, doors, windows, and trim in a very short time and can attack the building even before completion. If treatment of earth at the building perimeter is not part of the building construction contract, then earth and exposed wood surfaces near grade should be treated by the maintenance staff or contract exterminator as soon as possible after occupancy.

Exterior Building Care, original chapter by Alan Anderson, of Phillips, Swager and Associates. Third Edition review by Keith Middleton, of Middleton and Associates.

14 / Roofing Care

Built-up Roofs

Built-up roofing consists of several layers of roofing felt bonded together with bitumen and overlaid with a flood coat of bitumen into which protective gravel is embedded. Some lightweight roofs, steep roofs and roofs of irregular shape have a glazing coat of steep asphalt without gravel. The bitumen may be either coal tar pitch or asphalt. The roofing felt is an organic or mineral material impregnated with coal tar or asphalt.

Hence, there are three basic types of built-up roofs:

1) Coal tar (felt and bitumen) with gravel overlay;

2) Asphalt (felt and bitumen) with gravel overlay;

3) Asphalt (felt and bitumen) with a glazed asphalt finish.

A few roofs use a finish of heavy asphaltic felt with factory-applied mineral granules.

CHARACTERISTICS

Built-up roofs have a tendency to shrink. As the coal tar or asphalt saturants begin to dry out the membranes become brittle, particularly when cold. Drying accelerates when gravel is displaced and the sun can hit directly upon the surface coating. Coal tar systems tend to seal themselves during hot weather. Asphalt systems do not reseal themselves. Surfaces glazed with asphalt are easy to inspect; however, they dry out faster than gravel coated surfaces and must be recoated. Many smooth roof coatings (glazes) become thick; when they shrink, large cracks develop. This condition can be alleviated by painting the smooth asphalt glazed roofs with an asphalt-based, fibered aluminum paint. Shrinkage shows up most at gravel stops and wall flashings.

Gravel stop joints are generally located at the roof perimeter. Because the gravel stop is necessarily bonded to a built-up roofing membrane, a crack in the membrane will develop at almost every gravel stop joint each year. These cracks must be patched at least once (preferably twice) a year with a mastic that is compatible with the roof system (coal tar or asphalt).

Composition flashings which occur at parapets, walls and roof projections usually deteriorate faster than the roofing and sometimes are pulled loose, torn at the corners or pulled apart at the seams. Normally, these flashings extend up the vertical surface at least 8 inches to prevent water from leaking into the wall.

Flashings are usually nailed at their tops to the wall and attached to the backing with cement (tar system) or steep asphalt (asphalt system). They are protected at the top with a metal counter flashing. Mineral coated and modified bitumen flashings can be coated with a fibered, asphalt-based aluminum coating, which will increase their life and make fractures easier to find on subsequent inspections.

Blisters usually result from trapped moisture and are repairable by your roofer. Until they are removed, keep the blisters covered with gravel or reflective surface and do not walk on them in cold weather.

Built-up roofs develop bare spots (gravel washed away) for a number of reasons. If a roofing

Roofing Care, original section on built-up roofing by Alan Anderson, of Phillips, Swager and Associates. New material provided for Second Edition by Richard L. Doyle, of Richard L. Doyle and Associates. Original section on single-ply roofs by Keith Middleton, of Middleton and Associates. Both sections reviewed and updated for Third Edition by Keith Middleton.

ply shows through the flood coat or if the flood coat has eroded away, the condition should be inspected by a roofer or architect. Depending on exposure, repair work is usually needed around the tenth year for asphalt systems, about the fifteenth year for coal tar pitch systems, and sooner for glazed coated surfaces. If the flood coat—after scraping with a knife—is at least 1/16" thick, apply a compatible mastic to bare spots and imbed clean gravel.

Splits in the roofing membrane usually constitute an emergency and require a roofer. Splits in the flashing at gravel stop joints are to be expected, but they must be regularly inspected and maintained. Splits at gravel stop joints seldom migrate more than 6 to 8 inches and can be patched with compatible mastic twice a year in conjunction with spring and fall maintenance.

Identification

If records do not identify the type of roof, obtain a small ball of bitumen from the roof. Make sure it has no gravel in it. Drop it into a container of water saturated with table salt. If it floats, it's asphalt; if it sinks, it is tar.

Most roof specialists agree that tar and asphalt products are not compatible with each other under most conditions and should not be mixed. Accordingly, use coal tar mastic for patching tar systems and asphalt mastic for asphalt systems. Some manufacturers make a coal tar mastic with selected oil additives which they claim is satisfactory with either system.

INSPECTION

Built-up roofs should be carefully inspected at least twice a year, preferably in spring and fall. If maintenance personnel are not experienced in roofing inspection and maintenance, they should seek help from a roofing contractor or other qualified individuals.

Materials required consist of the following:

1) Multiple copies of a small-scale plan drawing of each roof. Each plan drawing should be identified as to the date the roofing was installed and the roofing type (such as built-up asphalt and gravel or tar and gravel).

2) Checklist (see the Annual Building Inspection Checklist in the Management Tools Appendix).

3) Tape measure.

4) Pocket knife.

5) Camera.

On the drawing of the roof, show locations of flashings, gutters, downspouts, expansion and control joints, parapets, and roof penetrations. Then mark the location of defects on the drawing for reference in planning repairs and specifying work.

At each inspection—spring and fall—report the general condition of each roof, noting visible blisters, ridges, splits, bare spots, and alligator

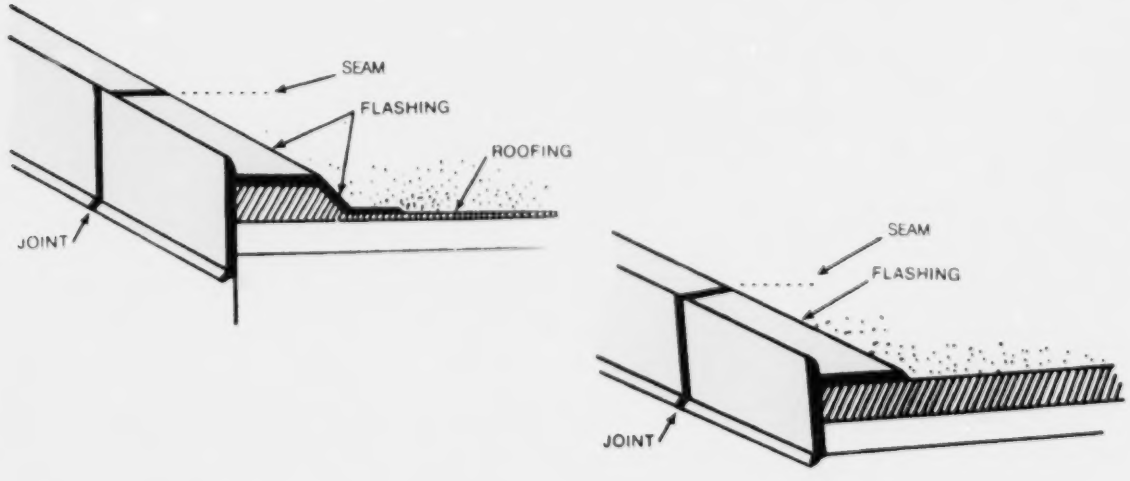

Figure 14-1—Raised gravel stop (left) and flat gravel stop (right) usually require patching once each year at joints and flashing edges. Also look for ply tears at gravel-stop seams every six months and patch if necessary.

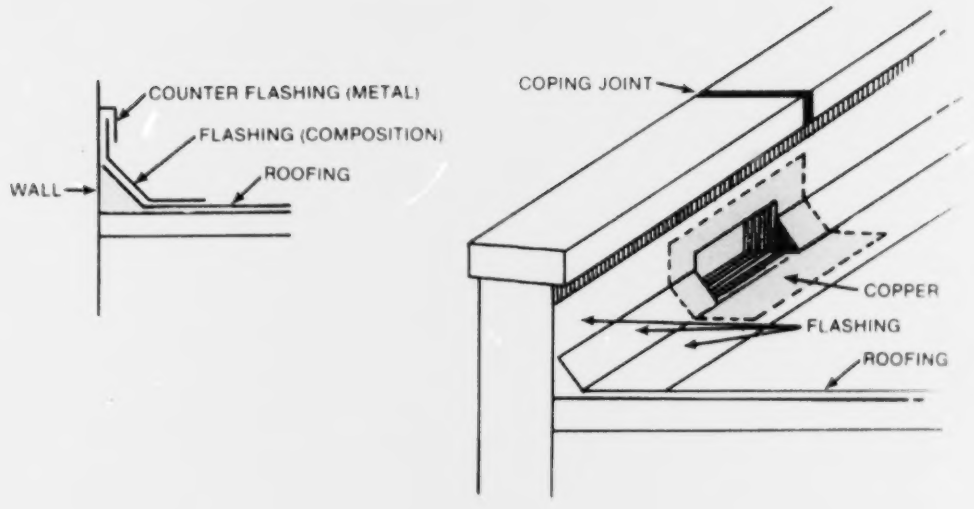

Figure 14-2—A typical wall flashing (left) and typical parapet (right) show locations most likely to need patching, including seams and splits in composition flashing.

cracking; condition of composition flashings and metal counterflashing; condition of gravel stops, scuppers and drains and pitch pockets. Check for open joints in coping stones and gravel stop flashing splits. Note evidence of ponding. Measure the areas requiring repair. Photograph unusual conditions and date the print.

Drains should be cleaned out and debris removed from the roof before spring rains and after leaves have fallen. Plan systematic repair for the summer. Keep a record of roof repairs made, their extent, date and by whom. This record, with inspection reports and dated photographs, can be helpful in diagnosing maintenance problems and anticipating major maintenance.

The maintenance supervisor should be familiar with the details of all roof guarantees and service agreements. He should see that any emergency repairs or maintenance is done in compliance with the guarantor of bond and that required reports are forwarded to the guaranteeing company.

Although an architect should be consulted in planning major roofing work, the school maintenance staff should be able to perform most routine work.

Spring Maintenance

- Remove debris from roof.
- Clean out roof drains, gutters and scuppers.
- Patch gravel stop flashing (see *Figure 14-1*).
- Re-cover bare spots.

Fall Maintenance

- Remove debris, including leaves.
- Clean drains, gutters and scuppers.
- Patch gravel stop flashing (see *Figure 14-1*).
- Patch flashing splits (see *Figure 14-2*).
- Patch roofing splits. (This is a temporary patch to suffice until roofer can apply permanent patching.)
- Re-cover bare spots.

Safety Considerations

- Use hatchway access to the roof instead of portable ladders whenever possible.
- Wear rubber sole shoes when walking on roofs that have a slope.
- Relegate inspection and maintenance of dangerous locations to those equipped for such work.

Energy Considerations

- Schedule appropriate repair or replacement of wet insulation before the winter season.
- Applying a reflective finish to black roof surfaces will reduce energy usage, improve comfort and increase roof life.

Single-ply Roofs

Typical single-ply roofing consists of one layer of water-impervious material. Although the single-ply roof may be installed by a variety of methods, the most common methods are as follows:

1) Material is secured over the roof deck and/or deck insulation by ballast (approximately 2-inch layer of rocks).

2) Roofing is attached to the substrate (insulation of former roofing system) by adhesives.

3) Materials are mechanically secured by various methods, such as anchor strips or anchor patches. (Nail or screw anchors fashioned with a gusset are secured to the anchor head. Gusset material is, in turn, attached to the underside of the single-ply sheet.) The number of mechanical fasteners is determined by wind conditions and the desired uplift rating. Modified bitumen sheets are secured by mopping them down in hot asphalt.

CHARACTERISTICS

Single-ply systems are manufactured in a multitude of chemical formulas, all exhibiting pliable, rubber-like characteristics. The thickness of the sheet material usually varies from 1/32 to 1/16 inch thick; however, the single-ply materials described as modified bitumen sheet may run around l/8-inch in thickness.

The materials in single-ply systems display a variety of textures and colors, usually depending upon product chemistry. Some single-ply sheets incorporate a reinforcing mesh, whereas some are manufactured without reinforcement. Also, some materials are surfaced with reflective coatings to deflect solar heat. As the chemistry of these various products differ, so differs the resistance to exposure imposed by environmental conditions prevailing in the area and reaction with substrate chemistry.

Foam Materials

In addition to sheet materials, foam materials (applied by spraying), which usually incorporate urethanes or silicones, are available. The better quality foam systems may be urethanes with silicone rubber or other top coating applied by spraying. Although the industry is not in complete agreement, most spray-on applications are l-inch to 2-inches thick. The value of this type of single-ply application depends greatly on the skill of the applicator in the field, the conditions of the substrate, and the climatic environment. Foam systems do not usually call for ballast; however, in some installations aggregates have been used to protect the surface.

REPAIRS

Repair of single-ply systems is as simple as patching a leak in a tire once the location of the leak is identified. Access to the area to be repaired is relatively convenient in either attached ballast-free installations or ballasted system installations. The surface of the ballast-free, attached installation is directly exposed, and the surface of the ballasted system is exposed by pushing aside the unattached ballast material. Once the leak is located, however, application of a patch is subject to a variety of complexities:

1) It is absolutely essential that the exact chemistry of the sing'e-ply sheet system be determined prior to repair. Patch material and application procedures must be compatible with the original material. Some products are adhered at joints, laps, and overlay patches by heat alone, whereas others are adhered by adhesives and sealants formulated especially for the specific product.

2) Some single-ply sheet product manufacturers by-pass application contractors and provide their own repair teams to assure repair match-up with the specific single-ply system.

3) If a local roofing contractor is employed to apply patches, it is advisable to require the contractor to submit a letter of certification from the product manufacturer confirming the match-up between the repair patch and the original roofing material.

4) Repair of spray-on (foam) systems requires the services of a specialist.

Beyond these considerations, the repair procedure is simple and usually inexpensive.

Records

It is important that a complete set of records be kept to facilitate future maintenance on a single-ply system. Records should contain the following information:

Base Product Chemistry—including information regarding chemicals and compounds that

might deteriorate or shorten the life of the system.

Product Manufacturer—Name, address, telephone number.

Application Date—This date is extremely important because single-ply system manufacturers are continually changing product chemistry to improve their products for various substrate and environmental exposure conditions, or to stay competitive in the marketplace.

Additional Helpful Information—Roofing contractor's name, address, telephone number; guarantees; inspection reports; repair reports.

Even with the relative simplicity of repair maintenance, it is necessary to be sure that any roofing contractor employed to repair a single-ply system is certified by the single-ply system product manufacturer to make repairs.

GENERAL MAINTENANCE

Single-ply systems should be inspected at least twice a year, preferably in the late spring (after trees have shed seeds and related support growth) and in late fall (after trees have shed leaves and dead branches). Each inspection should include the following steps:

1) Remove all debris, including leaves.

2) Inspect at corners and around roof equipment for wind dislocation of ballast materials. Carefully replace ballast material over bare areas.

3) Identify the area needing repair (by location and size) in the inspection report and promptly replace the ballast. Do not leave ballasted systems unballasted overnight.

4) If leaks have been noted, the roof sheet (if ballasted) should be cleared in suspect areas to locate possible deteriorated material, flashing lap failures, and/or punctures.

5) Be sure that all drains are clear and open for drainage.

Walkways

It is essential that inspections and repairs be made with considerable care on ballasted systems. The turning and twisting of a foot, for example, can cause a ballast rock to puncture the single-ply sheet.

Exercising care in maintenance of rooftop mechanical equipment can become a very important factor in extending the life of single-ply roofing systems. For attached single-ply systems, it is all too likely that equipment maintenance personnel will inadvertently damage the roof in moving to and from the equipment, by spilling oil around the equipment, or by dropping or setting tools and equipment directly onto the roof. Ballasted single ply systems are just as subject to all the same causes of damage as attached single-ply systems; moreover, ballasted systems are probably more susceptible to traffic damage than the unballasted systems.

A significant way to reduce roof damage is to provide walkways to rooftop equipment. A walkway can be constructed of thin, pre-cast concrete patio blocks set directly over the single-ply materials with felt separation sheets extending 3 to 4 inches beyond the edges to prevent abrasion to the roofing material. Walkways should also be provided around rooftop equipment as a work surface for maintenance crews.

Inspections

At each inspection, spring and fall, record the general condition of each roof, noting the appearance of surfaces, especially any deterioration indicated by dulling and drying. Many roofs incorporate areas which, because of their protected locations, are shielded from severe environmental elements, particularly sun and atmospheric fallout. These protected areas can be helpful in judging apparent surface deterioration by comparing them with surface materials exposed to severe elements. Another way to judge deterioration is to retain a piece of unexposed surface material from the time the roof was first applied.

Also, be sure to check for deterioration of flashing and splice laps with particular attention to edge sealant deterioration and lap delamination. At each inspection, note the age of the roof as an aid in judging the condition of surfaces, laps, and splices. Noting the age will help anticipate major repairs or replacement for purposes of budget planning.

— NOTES —

Section FOUR

Maintaining School Grounds

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15 / Effective Grounds Management

The first step in managing a grounds maintenance program is to identify all necessary tasks and categorize them into seasonal jobs. A variety of circumstances will limit the amount of work that may be finished; thus, it is essential that priorities be established.

The second step is to devise an efficient combination of people and machines.

The third is to develop a schedule that will accomplish the most work in the time available. To eliminate last-minute confusion, work areas should be identified, equipment should be available and in good working condition, and personnel must have a thorough knowledge of job requirements and limits.

For these reasons, preseason preparation cannot be over-emphasized. The following steps will ensure that the best use is made of time and manpower available:

- Repair parts for equipment must be ordered soon after the using season ends.
- Rebuilding of machinery should be well underway at least two months before it will be needed again.
- A judicious inventory of spare parts should be on hand to minimize down time.
- Often, a spare machine is a wise investment that will keep production rolling if a breakdown cannot be repaired immediately.
- It is advisable to keep track of maintenance costs on each type of machine. If repair costs and down time are excessive, consider changing to a different make or model.

A certain amount of hand labor always will be necessary in grounds maintenance. However, increasing labor costs dictate that each supervisor must continue to search for the right piece of equipment for the job. If unsure of what to buy, consult with other supervisors who have similar responsibilities. Most are happy to relate their experiences and will "tell it like it is." Before purchasing, it is usually possible to try out a piece of equipment to learn if it really is capable.

Be sure that everyone responsible understands the importance of preventive maintenance. Adherence to manufacturers recommendations is essential if a machine is to return its cost in service.

A grounds maintenance team must be a well-integrated group of selected individuals, who must possess a wide range of knowledge and skills. In all phases of the grounds operation, safe working conditions, positive attitudes and correct procedures must be constantly emphasized. Few kinds of work present more potential hazards, since equipment and chemicals used are dangerous. But safety can be maintained if each person is properly aware of the responsibility to follow safe practices.

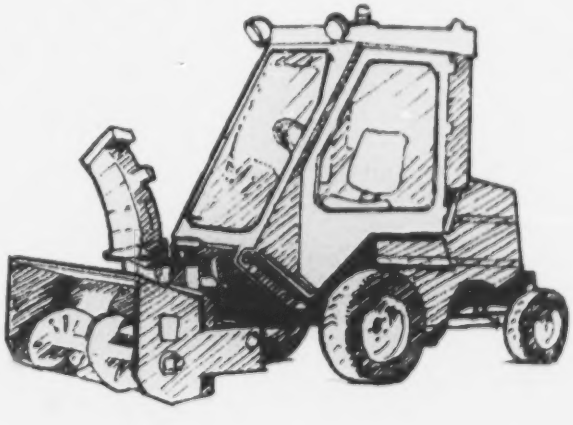


Figure 15-1—Snow blower mounted on a small tractor.

Effective Grounds Management, by David Bowman, Superintendent of Allerton Park, University of Illinois.

A Suggested Seasonal Schedule

Spring

1) Remove leftover leaves and thoroughly clean up the grounds. Pay particular attention to correcting conditions that damage mowing equipment.

2) When flower beds can be worked and danger of frost is over, plant spring flowers.

3) Fertilize lawns as soil tests and programs dictate needs.

4) Spot repair turf areas with sod. Lay no more sod than can be kept watered in summer dry season.

5) Begin mowing grass and trimming hedge when growth appears. If this activity falls behind schedule, spring weather may not allow work to be caught up.

6) Prune early flowering ornamental shrubs after spring blooming is over.

7) Check all hoses and irrigation equipment. Make needed additions and replacements.

8) Identify damage to streets, parking lots, and sidewalks caused by freezing and thawing or general wear and tear as soon as ground thaws. Prepare or contract summer oil and chip program as needed. Develop possible grounds improvement projects.

Summer

1) Finish broadleaf weed spraying before hot weather arrives.

2) Inspect newly-sodded areas, trees and shrubs regularly. Water when rainfall is inadequate. Don't wait too long to water.

3) Order and schedule delivery for replacement trees for fall and early winter planting.

4) Maintain leaf removal equipment and test-run for proper operation.

5) Improve and maintain streets, parking lots and sidewalks.

6) Hand weed shrub beds and other areas unaffected by control spraying. During dry periods, part of the mowing force can help.

7) Establish new lawn seedings in early August. Irrigate if necessary.

Autumn

1) Control early leaf fall by attaching mulchers to mower during final weeks of mowing season.

2) Repair turf with sod as long as soil conditions permit.

3) Fertilize lawns according to program established.

4) Before storing mowing equipment, analyze replacement and repair needs. Order parts and new equipment.

5) Go over all snow moving equipment and establish route and equipment responsibilities for personnel. Identify priorities.

6) Plant spring bulbs before the ground freezes.

Winter

1) Continually inspect and maintain snow moving equipment. Be sure all engine-powered equipment has enough gasoline in tanks to operate four hours before being sent to job sites. (See *Figure 15-1.* Also see Procedure 12 in Chapter 9.)

2) Establish a protected supply of size-selected sand, equal to one-half the average annual volume used. Replenish as used, as suppliers' stockpiles may freeze and become unavailable.

3) Keep an adequate supply of snow and ice-thawing chemicals on hand.

4) Continue area cleaning and trash pickup when snow is not on the ground.

5) Clean catch basins. Sweep streets and parking lots.

6) Order spring shrub and tree replacements. Arrange for potted spring annuals.

7) Develop or revise lawn care, plant pest and weed control programs for spring and summer. Order needed chemical supplies.

8) Clean and repair all equipment and tools needed for the growing season.

Overcoming Obstacles

Facilities that have been around for a long time seldom were designed with current maintenance methods in mind. Conditions particularly troublesome are overgrown landscape plantings, narrow or broken sidewalks, paved intersections with inadequate radii and improper lines or grades.

These areas place restrictions on equipment choices and operating techniques. A systematic elimination or rejuvenation of old and unattractive plantings may provide enough open space to allow a large riding mower to be used instead of a small, inefficient hand mower. Another example is a privet hedge that must be trimmed three or four times a season—reduced labor costs would pay for a Japanese yew hedge replacement that

needs attention only once a year.

Also, it often is beneficial to make certain physical changes in the landscape or modifications to facilities. For example:

- Bad drainage may be solved by regrading, tiling or installing french drains or catch basins.
- Reseeding of shade killed grass areas can be eliminated by substitution of the proper mulch.
- Deflectors installed at building exhaust vents will stop killing of plant material.
- Urns and trash containers at entrances will reduce area clean-up needs.
- A ribbon of concrete, asphalt, or gravel installed over plastic will eliminate weeds and growth where car bumpers overhang.

Some points to consider in making changes include:

- Analyze the condition and position of shrubs, trees and other plant material. Eliminate or relocate to create a balance between esthetic considerations and economical maintenance.
- Consider mature plant size when selecting ornamentals.
- Choose plant materials that are vigorous and compatible with all the growth factors at the site.
- Avoid trees and other plants known to be susceptible to insect and disease damage.
- Avoid repetitious planting of the same materials (monoculture). This may create an environment where insects and diseases undetected at first can become prevalent, causing high maintenance and replacement costs.

Encouraging Growth

Complete grounds maintenance must include giving trees, shrubs, and lawns a helping hand to maintain their health and vigor. A written record of the kind, number, location and condition of plants provides a basis for several programs designed to combat damage by insects, climate and people. Experts in ornamental horticulture and forestry at state universities are equipped to diagnose problems and recommend remedies.

Comprehensive soil testing is a first step in establishing a sound program. In general, trees and shrubs do not need special attention and can receive needed additional feeding during normal lawn fertilizing. However, it is advisable to help trees surrounded by expanses of concrete or asphalt paving. This urban environment weakens trees, particularly those established before the construction. Under stress, such trees slowly decline, become subject to disease and insect damage, and eventually die.

A Guide to Manpower and Level of Appearance

In maintaining grounds, appearance is a function of manpower and materials—cost, in other words. Until local experience proves otherwise, you can assume that 65 cents of each dollar spent on grounds maintenance goes for labor. The remaining 35 cents goes for equipment and supplies.

Here are three "levels of appearance" and the tasks and manpower required to maintain each level.

1) High standard of appearance will require one worker for every three to five acres to:

- Trim or replace trees as needed.
- Trim or replace shrubs as needed.
- Mow grass as needed.
- Use chemicals as needed.
- Provide sanitation as needed.
- Provide extra services.

2) Medium standard of appearance will require one worker for every five to 15 acres to:

- Trim trees and replace them selectively every one to three years.
- Trim shrubs three to four times a year and selectively replace them every one to three years.
- Mow grass as needed.
- Use chemicals once a year or every two years.
- Provide sanitation weekly.
- Limited extra services.

3) Low standard of appearance will require one worker for every 15 to 25 acres to:

- Seldom trim trees with few replacements.
- Trim shrubs once or twice a year with few replacements.
- Mow grass as infrequently as possible.
- Limited use of chemicals (or none).
- Monthly sanitation.
- No extra services.

Flexible Grounds Management

Effective, cost-controlled grounds maintenance is characterized by an attitude of always looking for better ways of doing things. If an accurate diary could be kept over a long period of time, a pattern would be seen of subtle differences in each major activity from year to year. An attempt to treat each year the same as the last, with hard, fast rules will result in decreasing productivity and declining vigor of the landscape. A suggested seasonal schedule of activities accompanies this section (see page 129). Note that this schedule may need to be coordinated with the building interior maintenance program in many situations, depending on the size of the staff and how the workload is divided.

16 / Tree and Shrub Care

Pruning insures proper growth and form. Caution should be taken to prune trees and shrubs at the proper time of year, using the following guidelines:

1) Use tools that are sharp and clean cutting.

2) Start shaping trees at planting (see *Figures 16-1* and *16-4*).

3) Diseased, dead or broken branches can be removed at any time.

4) Leave no stubs or ragged cuts.

5) If two branches are rubbing or interfering with each other, causing bark wounds, prune the weaker branch.

6) Always cut back to another branch or bud. If the end of the branch is dead, cut beyond to live, healthy wood.

7) To be sure the branch is dead and not dormant, slice the bark and look for green wood.

8) Prune off one-fourth to one-third of branch growth when planting plants with bare roots.

9) Bark wounds an inch or larger in diameter should be covered with an asphalt base wound dressing.

10) Thin and remove old wood from established shrubs. This produces more flowers and better fruit, and improves vitality of the plant.

11) Trees and shrubs should not obstruct the view from the windows of a building.

12) On all heavy cuts, make removal in three steps as shown in *Figure 16-1*.

PRUNING HEDGES

In the spring, heavily prune newly planted hedge down to a uniform height. Prune again in the summer after new growth has developed. This will encourage side branching and make a wide-based hedge easier to establish (see *Figure 16-2*).

PRUNING EVERGREENS

Shrubs: Do not remove lower branches, which should grow and branch to the ground. Do remove dead branches.

Broad-leafed evergreens (Mountain Laurel, Rhododendron, Azaleas, etc.): Do not prune except to remove dead wood. If plants reach an undesirable height, cut nearly to the ground. New growth will form at the base if plant is vigorous.

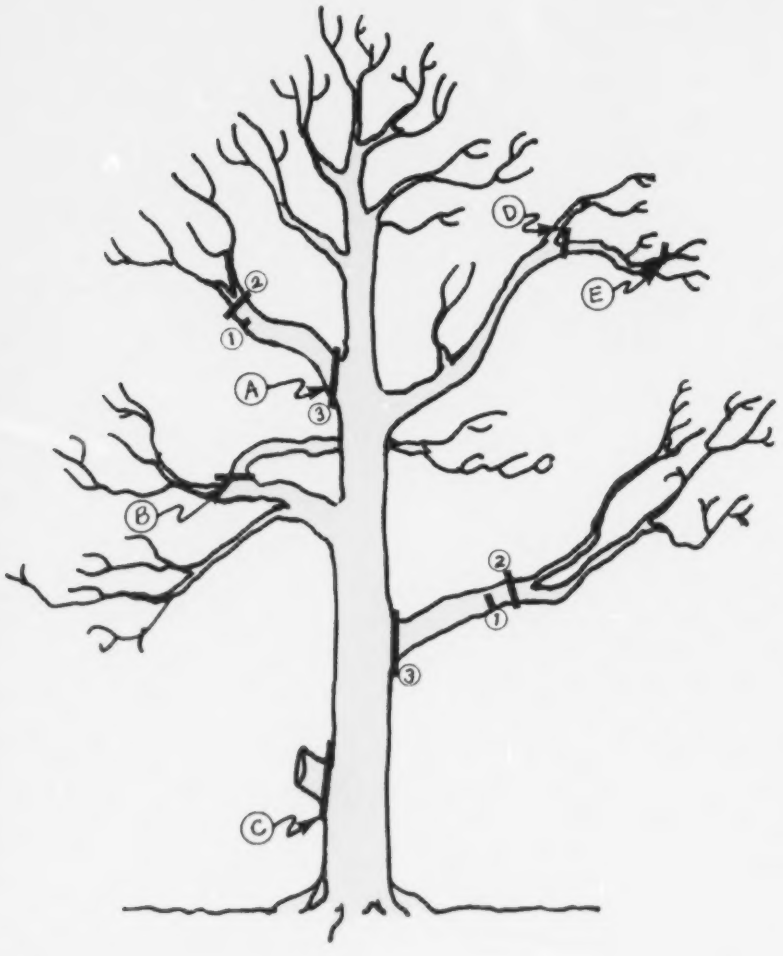
Narrow-leaf evergreens (Juniper, Arborvitae, Taxus): Prune in spring, removing whole branches. Prune no more than one-fourth of total plant growth. Cuts should be concealed so foliage may hide the branch stubs, leaving the plant in a more natural state.

Narrow-leaf evergreens (Spruce, Fir, Pine): These evergreen are not generally pruned, except when the plant is less than five feet tall, to increase foliage density. (See *Figure 16-3.*) Shear no more than one or two inches of foliage. Do not expose old wood, which cannot easily be covered because new growth from the wood of the branches is slow.

Spring flowering shrubs: Prune after the blooming period. This assures more flowering wood for the next year, because the flowers are borne on the wood from the year before.

Summer flowering plants: These plants that produce flowers on wood of the current year may be pruned in the spring before growth be-

Tree and Shrub Care, by David Bowman, Superintendent of Allerton Park, University of Illinois.



On all heavy cuts, make removal in three steps:

1. Make a partial "undercut."
2. Remove the limb above the "undercut."
3. Remove the stub at shoulder rings.

- **A** Remove weak crotches.
- **B** Remove "cross-over" or interfering branches.
- **C** Prune back to side branches, laterals, or main trunk. Cut flush; never leave stubs.
- **D** On average high cuts, use a pole saw.
- **E** On small high cuts, use pole pruners.

Figure 16-1—Good pruning techniques are essential in keeping diseased, dead, and broken branches removed at all times.

gins. When the plant becomes dormant, fall or winter pruning (after flowering) works well.

PRUNING SHADE TREES

Young shade trees need balance pruning. In the first year, encourage new growth by cutting branches to balance root loss. Limbs can be shortened from one-fourth to one-third. Remove structural deformities.

During the second and third years, remove fast-growing limbs that tend to crowd or compete with the main limbs. See *Figure 16-4* for guidance in shaping a shade tree.

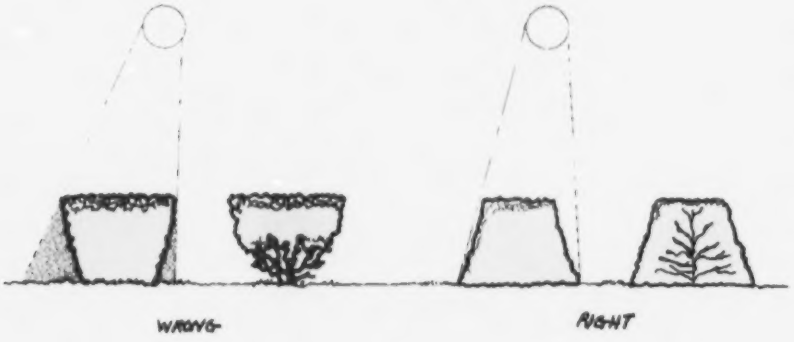


Figure 16-2—Wrong way to trim hedge is shown at left, where overhanging top edges shade the sides. The sides soon lose their leaves and become thin. In the properly trimmed hedge at right, the top is narrower than the base and the sides slope outward. Thus the entire hedge is exposed to sunlight and will grow healthy, compact, and dense.

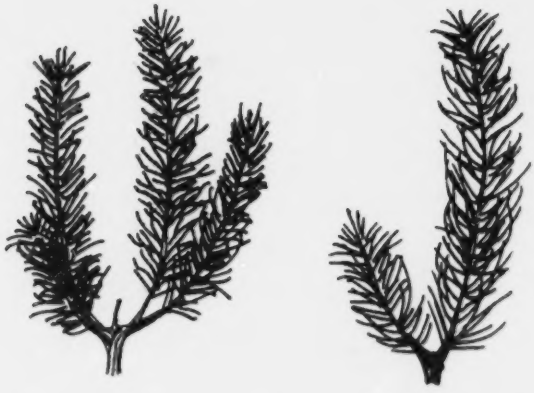


Figure 16-3—Evergreen pruning. The pine on the left shows a lost leader (stub in the crotch). The three one-year-old shoots will compete, probably making a triple-trunked tree. For corrective pruning (right), competing growth has been removed entirely or cut back to half, leaving the strongest, most upright shoot to serve as a leader. Pruning cuts should be sealed. In a few years the trunk will make sufficient secondary growth so the injury will not be noticed. Pines respond best to June pruning.

Fully-grown shade trees require little pruning except to remove dead and diseased branches.

PRUNING SHRUBS

Gradual rejuvenation: For plants that have become too large for the space they occupy or so old they are unsightly and do not flower well, see *Figure 16-5.* To prune, cut the oldest branches off at the ground. Leave the young stems, and gradually remove older wood over a period of two or three years. Some multi-stemmed shrubs that benefit from this method are lilac, privet, forsythia, viburnum, honeysuckle and barberry.

Thinning: For plants that are too dense, see *Figure 16-6.* Cut off a twig or branch that is attached to the main stem. Remove quick-growing sprouts.

Heading back: The purpose of this pruning

Figure 16-4—Starting with a young shade tree (left) proper trimming determines ultimate shape. For a compact, open spreading tree (center) remove the central leader at the height where the tree is desired to crown out. Side branching also is encouraged by removing terminal buds or pruning twig ends. For an upright growth (right) protect and encourage the central leader and remove the side or lateral growths. To develop a strong trunk, leave low side branches on for a year or two but keep them headed back and remove them as the tree develops.

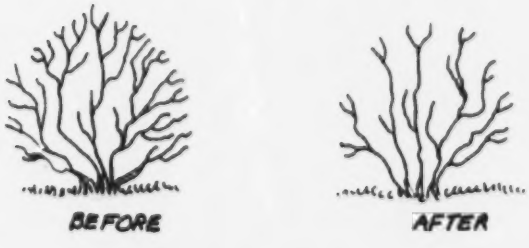


Figure 16-5—To rejuvenate old shrubs, cut the oldest branches off at the ground.

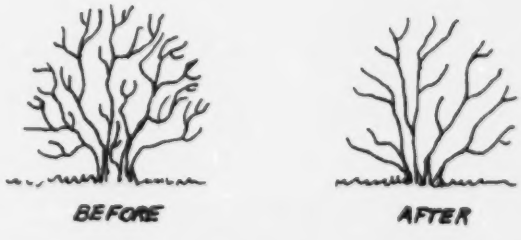


Figure 16-6—Thinning of shrubs that are too dense is done by cutting off twigs and branches where they attach to a main stem.

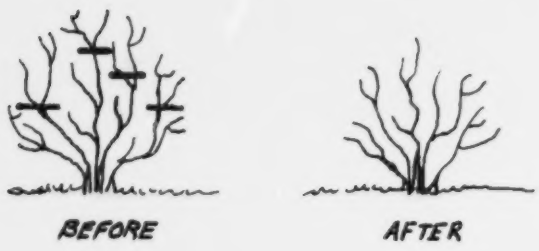


Figure 16-7—Heading back reduces plant size but increases density. Cut the terminal portion of a branch or twig back to a bud or another branch.

method is to reduce the height or size of the plant and encourage development of small shoots and buds. See *Figure 16-7*. Cut a terminal portion of a branch back to a bud of another branch. This creates more density.

Thinning and heading back methods work well together to keep large plants within bounds. Do not prune the stems and shoots the same height. This gives the plant a "crew cut" appearance and causes excess growth at the top. See *Figure 16-8*. Thinning helps open the center; heading back controls height.

ROOT PRUNING

Roots of a plant that is to be transplanted should be pruned one year before the plant is moved. This develops a denser root system with more roots in the ball.

During the summer, after the plant stops growing on top, push a sharp spade to its full depth into the ground around the plant in a circle twelve inches in diameter for every inch of stem diameter.

Water as needed. During the rest of the summer, the plant will fill out the root ball. The following spring, during its dormant stage, the plant is ready to be moved.

Established trees: Exposed surface roots should be severed and dug out of the turf, a few at a time. The severed ends should be painted with tree wound dressing.

Figure 16-8—Poor pruning technique. Stems and shoots should not be pruned at the same height, because this gives the plant "a crew cut" appearance and stimulates excessive growth on the top of the plant.

17 / Building a Lawn

ESTABLISHING TURFGRASS

The general steps in establishing turfgrass for a good lawn are:

1) Make a complete soil test.
2) Rough grade.
3) Lime, according to test results.
4) Apply basic fertilizer.
5) Apply soil amendments, if needed.
6) Till above materials into soil to a depth of four to six inches.
7) Finish grade.
8) Apply starter fertilizer and work into top surface of soil.
9) Apply seed or lay sod.
10) Rake or drag to cover seed.
11) Roll lightly (for either seed or sod).
12) Mulch to prevent erosion and conserve moisture.
13) Water lightly and frequently.

Soil Testing

The best guide for proper establishment of turfgrass is a complete soil test. The results give pH and lime requirements and show the amount of phosphorus, potassium and organic matter present in the soil. Highly irrigated sites should be tested for soluble salts.

Rough Grading

Remove debris, including stones. Before applying lime or fertilizer, till the soil and rough grade. Where topsoil is to be replaced, rough grade to the contour of finished grade to facilitate all-over distribution of topsoil. Final depth of topsoil should be at least six inches.

Liming

If the lime requirement test shows a need for lime, broadcast and work in the correct amount of ground limestone (as shown by the test) to a depth of four to six inches. Where the test is not available, use at least 100 pounds of ground limestone per 1,000 square feet.

Fertilizing

Basic fertilization: For soil that has been tested, spread the recommended amount of fertilizer and work it in to a depth of four to six inches. For soil that has not had a complete test, use 50 to 75 pounds of 0-20-20 fertilizer or equivalent per 1,000 square feet. Spread and work in to a depth of four to six inches.

Starter fertilization: Before seeding, spread and rake fertilizer into soil about one inch. Use fertilizer with a 3-4-1 ratio in which one-half to three-fourths of the nitrogen is slowly available (20-24-6, 28-20-5). Apply three to four pounds per 1,000 square feet.

Soil Amendments

If the soil shows a lack of organic matter, work in the recommended amount four to six inches before applying starter fertilizer. Recommended sources of organic matter are sphagnum peat, leaf mold or a combination of the two. Well-rotted sawdust or manure may be used.

Finish Grading

To finish grade, rake before seeding or sodding. Light rolling will show any irregularities. A firm profile is required to prevent settling later.

Building a Lawn, by David Bowman, Superintendent of Allerton Park, University of Illinois.

Seeding

See page 138 for a discussion of turfgrass varieties that are best for Illinois. In other states, consult the horticultural department or the grounds manager at a nearby university for guidance in selecting turfgrasses and seeding times.

Late summer to early fall is the best time for seeding permanent turfgrass. Recommended times for varying conditions in Illinois are:

Southern Illinois—September 1 to October 5
Central Illinois—August 20 to October 1
Northern Illinois—August 10 to September 10

Small disturbed areas should be seeded as soon as possible, regardless of the best seeding time. Where spring seedings are necessary, for best results seed no later than:

Southern Illinois—April 1
Central Illinois—May 1
Northern Illinois—May 30

Sow the seed mixture recommended for the climate in your region and adapted to specific conditions:

Area of heavy shade (less than one-third of day in direct sun): Apply four to five pounds of Creeping Red Fescue or C-26 Hard Fescue per 1,000 square feet. These conditions might exist on the north side of a building.

Area of moderate shade (one-half to two-thirds of day in direct sun—under trees, for example): Sow four pounds of shade-tolerant Kentucky Bluegrass (Nugget, Aquila, etc.) per 1,000 square feet.

Area of little or no shade: Apply four pounds of a good Kentucky Bluegrass (Baron, Victa, Aquila/Parade mix, etc.) per 1,000 square feet.

If the newly-seeded area will be subject to high traffic, a mixture containing the good Kentucky Bluegrass and fine-leafed perennial Ryegrass (Pennfine, Manhattan) should be used at six pounds per 1,000 square feet. The area, once established, should perform well under moderate maintenance programs of fertilization, watering and aerification.

Rake lightly or drag area to cover seed no deeper than one-fourth inch. Roll lightly to firm soil around seed.

Sodding

Check vendor inventory of various sod mixtures. Choose healthy, active sod that is weed-free.

Mulching

Use clean straw or marsh hay. Lightly mulch seeded area (mulch may be left on the area to decompose). Do not cover the area completely, as heavy mulch must be removed after seed germination.

TURFGRASS CARE

Fertilization

Fertilization is an important key to improving poor lawns or maintaining good ones. Grass and green plants need the following:

Nitrogen for growth and good leaf color;

Phosphorus for deep healthy roots;

Potash to promote disease resistance. For many plants, potash also is necessary to the growth process.

Mowing

For a well-groomed appearance and long life, mowing practices are important.

Height of cut: Creeping type plants produce adequate leaf surface at very low cutting. Kentucky Bluegrass and fine leaf fescues should be cut high (1 1/2 to 2 1/2 inches) to assure satisfactory growth. Bunch-type grasses (tall fescue and rye grass) should be cut 1 1/2 to 3 inches.

Frequency of cut: Frequency is determined by the amount of growth. Remove no more than one-third the total height at any one mowing.

Mowing practices: Be sure mowing equipment is in good operating condition. Dull, improperly adjusted equipment damages leaf tips and invites disease organisms. Reel type mowers are recom-

Lawn Mowers

Because lawn mowers represent a major investment, it pays to buy only those that meet performance criteria. For example, a mower must have:

1) Exceptional maneuverability of zero to 12-inch turning radius at the cutting head.

2) "Out-front" mowing to eliminate tire streaking.

3) Even distribution of cut grass across the width of the cutting head.

4) Adequate ratio of engine horsepower to cutting width (one horsepower for every four inches of cutting width).

5) Minimum use of V-belts in drive and cutting system.

6) Available with closed cab, lights, chains, snow thrower, broom, and angle dozer for snow removal.

Figure 17-1—A typical riding mower.

mended for cutting quality turfgrass. Rotary mowers should be used where grass control is more important than appearance. (See *Figure 17-1.*) Dry grass cuts easier with a rotary mower; therefore avoid mowing wet grass. Cut new grass when it is two inches high. After three cuttings, apply a general weed killer.

Watering Turfgrass

Applying water: Sprinklers should be set for even distribution, allowing the soil to absorb the water. Too large a volume of water in a concentrated area causes surface run-off and wastes water.

Amount: Enough water should be applied to thoroughly wet the root zone. The type of soil determines its water-holding capacity. One inch per week, either by rainfall or irrigation, is needed.

Frequency: This depends on type of grass and climate—rainfall, temperature, wind movement and humidity. Irrigate to provide vigor and growth as necessary.

Newly-seeded areas need to be kept moist during germination and until the plants are established. Water lightly and frequently.

Turfgrass that is wilted enough to retain a footprint needs watering. When plants show signs of wilting, water deeply. Shallow watering encourages weak turf.

GROWING TURF IN THE SHADE

Turfgrass may fail under trees because of competition for water, light and nutrients. The following practices may improve turf under trees:

1) Use shade-tolerant grasses, such as Pennlawn Creeping Red Fescue, Chewings Fescue, Alta or Rebel Tall Fescue, Poa Trivialis (rough bluegrass).

2) Fertilize the grass at higher rates than normal.

3) Perform deep watering to prevent tree roots from surfacing.

Turfgrass Varieties for Illinois

Kentucky Bluegrass

This species is widely used and thrives in sunny areas. It tolerates occasional drought and comes back quickly when adequate moisture is provided. Kentucky Bluegrass does not tolerate dense shade; therefore, mixtures of the bluegrass with Creeping Red Fescue should be used for variable light conditions.

Baron, Bristol, Victa and Vantage are the improved varieties of Kentucky Bluegrass used in Illinois for high-level maintenance lawns. Their low growth results in a dense turf and is superior to most varieties of Kentucky Bluegrass in leaf spot tolerance, appearance, vigor, and general turf qualities.

Maintenance: Most Bluegrasses perform well within a 1 1/2 to 2 1/2 inch mowing height. Both Baron and Victa can be cut from 1 1/4 to 2 inches. Generally, four pounds of slow-release nitrogen per 1,000 square feet per year is required for a Kentucky Bluegrass lawn.

Dethatching and aerification may be required, especially in areas of high traffic and heavy use.

Ryegrass

Ryegrass is actually a name given to two closely related grasses. Annual Ryegrass germinates in a few days, gives protection for the slower-developing bluegrass and conserves moisture. Perennial Ryegrass such as Pelo, NK-100, or Manhattan, may be mixed with permanent grass at no more than 20 percent of the mixture by weight.

Maintenance: Keep Ryegrass 1 1/2 to 2 inches mowing height. Two pounds of slow-release nitrogen per 1,000 square feet per year should be enough fertilizer.

Tall Fescue

This grass is durable, grows well in sun or light shade, and is used for playgrounds and athletic fields because of its low maintenance requirements. It is not desirable in a fine lawn, because the fescue tends to form large clumps. Once established, Tall Fescue can be removed only by digging out each area by hand or by sod-cutter. Rebel is an improved variety.

Maintenance: To seed Tall Fescue, use 10 to 12 pounds per 1,000 square feet. Mow to a height of two or three inches.

Creeping Red Fescue

This is a rapid germinating grass used in seed blends for moist, shady locations. Because it establishes quickly, it gives protection to slower germinating varieties such as bluegrass. It gives a fine texture to the turf.

Maintenance: For best turf performance, mow regularly at 1 1/2 to 2 inches. Two pounds of slow-release nitrogen per 1,000 square feet per year are required.

4) Remove trees that do not add beauty to the landscape or serve a purpose.

5) Prune trees as far as possible without destroying their function or beauty.

6) Prune shallow tree roots.

7) Plant new trees with care. Shade trees should be a minimum of 50 feet apart.

8) Plant trees that present minimum competition to grass (linden, honey locust, bald cyprus).

9) Provide good drainage and aeration.

10) Fall seed the turf. Trees then offer less competition for water, light and nutrients.

11) Shaded grass should be mowed higher than the same grass in the open sun.

12) Control weeds to reduce competition for water, light and nutrients, but *do not use dicamba herbicide.*

13) Remove leaves and other debris promptly.

14) Use other types of ground cover, such as baltic ivy, periwinkle, or pachysandra.

AERATION OF TURFGRASS AREAS

Compacted soil as thin as one-fourth to one-half inch greatly reduces nutrient penetration, water infiltration, and oxygen and carbon dioxide diffusion.

Mechanical aeration is a means of reducing this serious condition. Aerating machines punch holes in the thatch layer, creating an artificial system of large pores through which moisture and nutrients can enter the soil. The pores also create a breathing system through which carbon dioxide can escape and oxygen can enter the soil.

Spring and early fall, when the desirable grasses are growing vigorously, are the best times to aerate. Aeration reduces plant population, and unless it is done at the proper time, the turf area may take several months to return to an attractive lawn.

Aeration provides several benefits. It increases surface drainage, relieves soil compaction, provides openings for mulch to work in, allows air, water and nutrients to penetrate the soil surface, decreases disease and insect damage, and increases plant density.

Generally, two types of aerators may be used. The aerator with solid spikes must penetrate four to six inches into the ground. The coring-type aerator needs to penetrate only two to four inches, and removes a soil core. Any penetration less deep is a waste of time.

MOSS IN THE LAWN

Factors that may cause moss in the lawn include low fertility, poor drainage, too much shade, high soil acidity, and soil compaction. Some corrective measures are:

1) Have a regular, balanced fertilizer program.

2) Remove established moss with a rake, "burn" with ammonium sulfate or spray with copper sulfate. Apply concentrated amounts of ammonium sulfate directly on moist moss. Do not water into soil. Use five ounces of copper sulfate to four gallons of water per 1,000 square feet.

3) When the moss has been removed, correct the basic cause and follow with good management practices for a dense, vigorous turf.

18 / Caring for Bituminous Paving

Generally speaking, bituminous paved surfaces (blacktop) do not wear out. That is, the material itself does not. What it does do is dry out and erode away. However, bituminous paving that is not properly applied, applied on an unsatisfactory base, or exposed to directional friction (heavy vehicle stops) does break down.

The following maintenance suggestions do not address the problem of improperly prepared asphaltic paving. Maintenance will not cause a bad paving job to become good. The primary purpose of maintenance is to retain the quality of a good pavement. The secondary purpose of maintenance is to repair asphalt paving which has not been properly maintained or has suffered spot deterioration.

PREVENTIVE MAINTENANCE

To prevent drying out, it is necessary to coat and recoat the surface as needed to retain plasticity and decrease oxidation from sunlight.

Scheduled Inspections

Parking lots, drives, etc. should be inspected for signs of drying out in late spring or early summer each year. Bituminous paving needing maintenance will appear dull, dry, possibly dusty in surface appearance. Cracking, usually described as alligatoring, may also show up. Such signs mean the paving should be promptly sealed to retain the evaporatives within the product and prevent further deterioration.

Materials and Procedures

There are two basic materials for sealing the surface of blacktop paving.

- Asphaltic base emulsions.
- Coal tar pitch emulsions.

Asphaltic sealer emulsions and coal tar pitch emulsions should not be compared as equivalent products for the same purpose.

Asphaltic emulsion sealers are generally used for drives, bus lanes, and delivery areas and as a base for special sealers for game courts in preparation for color coating. Dilution of factory prepared sealer products, prior to application, should be done strictly in accordance with the recommendations of the manufacturer.

Coal tar pitch emulsions are recommended for areas such as parking lots, combined parking lots-playground areas, and service delivery areas where oil or gasoline may drip from autos and trucks. Coal tar pitch emulsions should not be used as a sealer or filler base where color coats are to be applied.

Application and Conditions

Application is usually by rubber applicator blade. However, application devices range from small, self-powered machines to large commercial machines. The application method, therefore, should be selected according to areas to be sealed, budget and manpower available.

Sealing should be a two-coat application, each providing 100 percent coverage. The application should never be so excessive as to allow puddling on the surface.

Before applying maintenance sealer, the paved area should be cleaned and corrected if necessary to drain free of ponding water. Sealers should be applied under the following conditions:

- The surface should be clear of all foreign and

Caring for Bituminous Paving, original chapter and Third Edition review by Keith Middleton, of Middleton and Associates, Normal, IL.

loose materials prior to application;

- Fair weather at minimum 50 degrees F for 48 hours prior to application;
- Fair weather at minimum 50 degrees F forecast for a minimum of 24 hours following application and preferably 48 hours.

Sealers, Fillers and Color Coats

Special products are available to perform as a sealer or sealer-filler and are recommended for application preceding color coat for game courts. Many pre-colorcoat sealer emulsions contain graded sand for filling large cracks and building up for drainage in areas which would otherwise pond water.

Color coats are usually an acrylic latex material for application over asphalt emulsion sealers. However, color coating materials differ from product to product and the manufacturer's recommendation should be strictly adhered to as to base conditions and application procedure. It is essential that a surface to receive a color coat be corrected to drain prior to application. Color coats should be applied in two coats over completely sealed and drained surfaces for satisfactory results and long life.

REPAIR OF PAVING

Here are some asphalt paving problems and ways to correct them.

Soft Areas

Soft areas may result from oil or gasoline dripping, improper aggregate base, thinned out bituminous paving installation, water penetration and resulting frost heave.

Clean away deteriorated surfaces, apply special asphaltic primer and special sealer-filler to bring up to level, followed by surface seal application as described under "Preventive Maintenance."

When deterioration is severe, it may be necessary to cut out the area and improve the base or increase paving thickness.

Long Cracks

Open cracks may result from alternate expansion and contraction, base settlement or water penetration allowed by neglect of preventive maintenance. It is essential that vegetation not be allowed to take hold in cracks.

Repair procedure should include cleaning out foreign material (in some cases widening the crack for thorough cleaning), filling the crack with a special crack filler product, followed by timely sealing of the surrounding surface as described under "Preventive Maintenance."

Chuckholes and Depressions

Chuckholes are caused by an inadequate base, inadequate paving thickness, water penetration and frost, overloading, or neglect of preventive maintenance. A borderline-quality bituminous pavement may well handle an applied load during summer and winter; however, this same load would be a damaging overload in the spring when frost is receding.

Repair will require cutting out the affected area, correction of the cause, and replacement. The patch and adjacent areas should then be sealed.

Edge Breakaway

Edges break away when the aggregate base is not extended beyond the asphalt paving edge at the time of installation. However, poor surface drainage accompanied by frost cycles also can cause edge failure. Adjacent surfaces should not be allowed to drain onto the edge of bituminous paving.

Correct the cause whether it be bad drainage or inadequate extension of the base outside the edge of the paving. Repair the breakout and reseal.

Deterioration Beyond Repair

Neglect of preventive maintenance, inadequate base or paving depth, poor drainage, or any combination of these causes may lead to deterioration that is beyond repair.

Determine the cause and make needed corrections (such as drainage improvement). Should the old bituminous paving and the old base together make up an adequate base, a new top surface of bituminous paving (at least two inches deep) will result in an adequate paving job

Topping over old bituminous paving should be preceded by a special one-coat bonding seal for best results.

RECORDS AND SCHEDULES

All asphaltic paving should be inspected annually in late spring or early summer and an inspection record should be kept on file and updated annually. A sample form for recording inspections is provided in the Management Tools Appendix.

19 / Maintaining Outdoor Athletic Surfaces

SOFT SURFACE RUNNING TRACKS

All-weather, soft-surface running tracks have been constructed of several synthetic paving materials. Some manufacturers, whose materials were used on existing tracks, have discontinued their product lines. The following maintenance information deals with the most common granulated rubber track surfaces used under average conditions. Where unusual circumstances exist, consult the product manufacturer.

Conditions for Repairs

Climatic conditions must be correct for repairing synthetic surfaces. Air temperature must be 60 degrees F. or above, and must have been so for several days prior to maintenance or repair work. It's also essential that the temperature remain above 50 degrees F. with fair weather for 24 hours following repairs.

The first step is to determine the cause of surface failure. A common problem of the rubber surfaced, all-weather track is in the base asphalt application (commonly called aggregate black-top base). Should a base repair be needed, such repair should be made prior to replacing the rubber surface. Base course repair should be performed as prescribed for maintenance of bituminous paving in Chapter 18.

Maintenance of the Surface

Every two to four years, depending on geographic location and exposure to hot sun, the surface should be thoroughly cleaned by brooming and water hosing. While still damp (but not wet) treat the surface by spray fogging with SS-1H asphalt emulsion.

The emulsion should consist of a sprayable mixture of SS-1H asphalt emulsion diluted with water. The usual mixture is 50-50 by volume. This treatment may be applied with a brush-type squeegee should suitable spray equipment not be available. Care should be exercised against either too light or too heavy an application. The surface requires adequate coverage but no puddles should result. Should puddles exist, they should be brushed out while still wet.

Minor Patching

Thoroughly clean all dust, dirt and other foreign materials by brooming and hosing with water. Spray as necessary to provide a clean bondable surface for application of the prime coat.

Prior to patching and repair procedures, the surface must be free of water puddles and damp (not wet).

Prime coat the area to be repaired with a coat of SS-1H asphalt emulsion and water mixture, usually a 50-50 mixture by volume. Apply with a brush-type squeegee or sprayer.

Apply a patching mixture of surface material of mastic consistency suitable for steel troweling in place. The mastic patching mixture should be mixed for application in small batches appropriate for the number of persons troweling. Use the following mixture (based on volume, not weight):

- Two (2) parts clean masonry sand (not too

Maintaining Outdoor Athletic Surfaces, original section and Third Edition review of soft-surface running tracks by Keith Middleton, of Middleton and Associates. New section on acrylic tennis court surfaces by Steve Olson, of Olson Brothers Recreational Services, Mundelein, IL.

fine) saturated with clean water.

- Two (2) parts undiluted SS-1H asphalt emulsion.
- Mix wet sand emulsion thoroughly.
- Add one (1) part rubber mixture as purchased from the original product manufacturer for patching purposes. Mix thoroughly with the sand and emulsion mixture. This may be purchased in drums and can be stored at proper temperature for future repair work.
- Add water to workable consistency.

Patching in a thickness greater than 3/8 inch must be applied in two or more coats, depending on repair depth needed. In cases requiring a second coat of patch material, the first application must be thoroughly cured before application of the second coat.

Prior to the second coat, the surface should be dampened. Where the first coat has been in place for too long prior to second coating (that is, appears to have a dulled and dirty surface), the surface should be recleaned, dampened and primed as described above.

After the patch has set up (no longer tacky) the patched surface should be rolled with a lawn roller to obtain a compacted surface. Following curing, the patched area may be scraped (with sharp-edged trowel or blade-like instrument) to level the surface and feather the edges to the adjacent surfaces.

Patched areas should be allowed to cure for at least three days before the track is put into service.

Tools may be cleaned with an approved solvent.

Do not expect repaired areas to reflect the same surface sheen and shade as the adjacent unrepaired surface. Future weather and exposure will blend the surfaces together, but never completely so.

ACRYLIC TENNIS COURT SURFACES

Acrylic tennis court surfaces, when properly installed, are relatively maintenance free. If the tennis courts are located under trees, the leaves should be cleaned from inside the fenced area as often as needed. The leaves hold moisture, which is harmful to the surface.

Properly installed tennis courts have a one percent slope every ten feet. In order to allow proper drainage, the run-off area should be at least one inch lower than the surface. The surrounding terrain should subsequently drain into ditches and/or swales to discourage standing water or back flow onto or under the court surface.

Minor Crack Repair

Asphalt tennis courts will eventually crack even under the best conditions. There is no product that will completely eliminate cracking on a tennis court surface. Proper maintenance will reduce the size of the crack and control the moisture content under the court surface. Cracks should be cleaned, sprayed with vegetation killer, and sealed with a mixture of Portland cement, silica sand, and latex. The mixture is hand-troweled into the cracks. The playing surface and lines should be touched-up as needed. It is normal for the asphalt to crack around the concrete fence footings. These areas should be sprayed periodically with vegetation killer to eliminate weeds and small trees from growing in the cracks.

Minor Bird Bath Patching

Normally, bird baths (areas of pooling) will be patched in conjunction with a complete tennis court resurfacing. Standing water on a properly sloped tennis court should not exceed 1/16" after one hour drying time. Areas requiring patching should be cleaned by high pressure water blasting as needed and filled with a mixture of asphalt emulsion and sand. The areas should then be feathered with asphalt emulsion to blend with the existing surface. The playing surface and lines should be re-coated as needed.

— NOTES —

Section FIVE

Maintaining Mechanical Equipment

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20 / Heating, Ventilating, and Air Conditioning Systems

Boilers

The boiler in a school building, whether it heats water or generates steam, has been constructed to meet various safety standards, including the code of the American Society of Mechanical Engineers. The burner and its controls are equipped to meet the safety requirements of the municipality and insurance company.

The boiler as purchased and installed is capable of safe, reliable, and efficient operation. Such satisfactory operation can be achieved year after year by following the basic maintenance program described in the operators manual provided with each boiler. This manual is a valuable aid in caring for the boiler.

Good boiler maintenance consists of observing, adjusting, cleaning, and lubricating various pieces of mechanical equipment on a regular basis. Boiler maintenance is either protective or corrective. The two may overlap, but usually protective maintenance tasks are routine and are aimed to prevent breakdown and to prolong the useful life of equipment, while corrective maintenance is the repair or replacement of parts as required by occasional breakdowns.

PROTECTIVE MAINTENANCE

Protective maintenance begins with initial start-up. This is the most important step affecting boiler life and the one that is most often abused. Some contractors, for example, may use a boiler for heating a building during construction, without adequate water treatment or other care for firing requirements. Thus, the school gets a badly scaled or otherwise damaged boiler.

Another important step in good maintenance is to keep a log book. Insurance statistics reveal that 75 percent of all overheating accidents occur at installations that do not use boiler logs. Fewer accidents occur where logs are kept, because equipment maintenance required by a log program usually prevents total failure of safety controls.

Heating, Ventilating and Air Conditioning, reviewed and updated for the Third Edition by Glen L. Bellows, of Buchanan, Bellows and Associates, Ltd., Bloomington, IL, with assistance from Scott Stevens, of Fred W. Kramer & Associates, of Bloomington, and Robert Foss, of Hunzeker Trane, Peoria, IL.

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Starting Up a New Boiler

Boiler start-up should be performed by the manufacturer's authorized agency. Because of the importance of a proper start-up, the sequence of steps involved is outlined here:

1) Most states require an official inspection. If not, the boiler insurance company will inspect. In either event, the inspection confirms integrity of design and conformance to ASME standards.

2) Inspect all gages, controls, water glass, blow-down piping, relief valves, and others. Short shipments, errors, and vandalism are not unusual.

3) Inspect for foreign objects on both fireside and waterside. Check interiors for rags, scrap material, and tools.

4) Run electrical equipment to check for correct operation and assure lubrication to rotating parts.

5) Fill with water and boil promptly to drive off dissolved gases to avoid corrosion. For steam, fill the boiler to water level. For water, fill the system until the black hand matches up with red hand on the altitude gage. Be sure the makeup water line is connected to the school water supply with an approved backflow device.

6) Start up the boiler and stand clear of fire doors.

7) Bring up the pressure and temperature slowly. Do not leave unattended while pressure and temperature are rising.

8) Record data in log book. The log book should show records of "events," such as routine maintenance or unscheduled maintenance. It should also show the protective or scheduled maintenance items. Date and sign the start-up record.

9) Operate *steam boiler* to clean the system. Run until oil and dirt in the piping have been washed out with the condensate and gone down the drain. Run until condensate stream is clear.

10) Clean all strainers.

11) Boil out the *steam boiler* to remove oil and grease. Fill boiler with water to normal level. Mix concentrate of water and one pound of caustic soda and one pound of trisodium phosphate for each 50 gallon capacity of the boiler. Be careful not to splash on skin, clothing, or eyes. Pour concentrate in boiler. Start firing. Boil water for five to ten hours. Drain and pressure flush the boiler interior. Refill the boiler to normal level and promptly reheat to 180 deg. F. The boiler is okay if the gage glass shows clear water. Repeat if glass shows dirty water. Add boiler compound, such as 95 percent sodium chromate plus 5 percent sodium borate (one pound per 50 gallons of boiler water) to keep pH somewhere between 7 to 11.

12) Boil out the *water boiler* and system by filling boiler and system with water. Mix in a concentrate of the cleaning compound—one pound of trisodium phosphate for each 50 gallons of water in the system. Circulate through the entire system for five to ten hours. Drain and pressure flush the boiler interior. Refill the entire system and promptly reheat water to 180 deg. F. Add boiler compound, such as 95 percent sodium chromate plus 5 percent sodium borate (one pound per 1,400 gallons of water) to keep pH somewhere between 7 to 11.

Starting Up After a Summer Lay Up

1) Check water level, controls, valves.

2) Check burner operability, fuel, combustion air inlet, chimney, etc.

3) Open water supply to boiler feed and supply and return valves on the boiler.

4) Start up boiler. Stand clear of fire doors.

5) Bring up the pressure and temperature slowly. Do not leave boiler unattended.

6) Examine all gages and safety relief valves.

7) Record data in log book. Date and sign.

8) On a start-up from cold conditions, condensation may occur but will stop when temperatures are stabilized.

9) If a second boiler is to be cut in after the first is fired up:

- Close its supply and return valves. Open condensate drain valves in header.
- Start up as described for the first one.
- When boiler pressure is up and matches line pressure, open supply valve.
- Open the condensate return valve.

Removing Steam Boiler from Service

For periods less than one month:

- Drain boiler water while warm (120 deg. F. or less), from bottom drain until it runs clear; then close valve.
- Refill to the top of the boiler.
- Add water treating compound: sodium sulfite to 100 ppm or sodium hydroxide to 400 ppm.
- Boil out all gases and then shut down burner.
- Seal the boiler by closing all boiler operating

Monitoring Boiler Operation (S=Steam, W=Water)

Daily Tasks

S W

- ✔ ✔ 1) Read and record the pressure gages and flue gas temperature gages several times daily.
- ✔ 2) Read and record supply and return water temps.
- ✔ 3) Check water level glass gage. Water should be visible in the glass at all times. If not visible, shut the burner off. Do not turn on feed water. Do not open safety valves. Let the boiler cool to below 212 deg. F., then add water until one inch shows in the gage glass. Do not start the boiler until the trouble is corrected.
  - Water in the gage glass should be clear. Any appearance of rust indicates corrosion. Make chemical check for pH. It should range from 7 to 11. Make check for chromate content.
  - Water line should be steady. Bouncing indicates priming or foaming and can be caused by too high a water level, excess dirt, excess oil, excess chemicals, or by over firing.
- ✔ 4) Steam - check the water gage and tri-cocks. Close the lower gage glass valve. Open the drain cock and blow the glass clear. Close the drain. Open the gage glass valve. Water level should bounce up immediately. If not, purge out the lower gage glass pipe line.
- ✔ 5) Blow down boiler to remove sludge and sediment. A clean, properly maintained boiler should not be drained except to remove sludge, to make repairs, or to lay up for long periods.
- ✔ ✔ 6) Check out the operating point of the operating control and of the high limit control.
- ✔ ✔ 7) Keep the boiler room clean. Good housekeeping is essential to efficient operation and safety. Don't let trash interfere with a competent operation.
- ✔ ✔ 8) Keep the burner cabinet door closed. Electrical contacts are very sensitive to dust and dirt.
- ✔ ✔ 9) Keep a constant check on the fuel supply (oil or LP gas). Don't depend on automatic delivery. These checks may spot leaks and prevent a hazardous situation.

S W

- ✔ ✔ 10) Visually check flame.
- ✔ 11) Analyze and treat water.
- ✔ ✔ 12) Record make-up water usage.

Weekly Tasks

- ✔ ✔ 1) Inspect all linkages on the burner controls and on the automatic draft controllers.
- ✔ ✔ 2) Turn off the power control switch to observe burner shut-down and the response of the flame failure equipment.
- ✔ 3) With burner on low fire, stop flow of makeup water. Allow water level to lower. If limit water cutoff (LWCO) fails to stop burner, repair immediately.
- ✔ ✔ 4) Air damper on the burner.
- ✔ ✔ 5) Valves in the gas train.
- ✔ ✔ 6) Pilot and ignitor, condition of the flame.
- ✔ 7) Analyze and treat water.

Monthly Tasks

- ✔ ✔ 1) Inspect burner.
- ✔ ✔ 2) Check out the limit control on the boiler. Shunt the operating control, allowing operation to continue so that you can check the functioning of the limit control. CAUTION: This step should be performed only by an authorized service representative.
- ✔ ✔ 3) Check out the burner flame detection control. Turn off burner control switch and close pilot manual gas cock. Turn on burner control switch, and determine that burner flame safeguard locks out on flame failure before the main gas valve is energized. Immediate corrective action must be taken by a competent serviceman if the flame safe-guard does not indicate flame failure.
- ✔ ✔ 4) Check the floor drains for proper function. If not used often, the water in the trap can evaporate. If necessary, add water to fill the trap.
- ✔ ✔ 5) Lubricate motors in accordance with the manufacturer's instructions. Don't over oil.

valves. Fill boiler to top.

- Clean soot off tubes and fireside surfaces.
- Place one pound of quicklime per boiler horsepower and seal up fireside. Be sure to remove the quicklime prior to startup. Use care, as quicklime causes serious skin burns on contact.

For periods of over one month:

- Drain boiler water completely while warm (120 deg. F. or less) from bottom drain.
- Place one pound of quicklime per boiler horsepower and seal up waterside. Be sure to remove the quicklime prior to startup. Use care, as quicklime causes serious skin burns on contact.
- Clean soot off tubes and fireside surfaces.

Corrective Maintenance

Corrective maintenance is the repair or replacement of parts as dictated by occasional breakdowns. Major repairs should be done by a

S	W	
✔	✔	6) Verify that combustion air motorized dampers operate properly.

Annual Tasks

S	W	
✔	✔	1) Disassemble the low water cut-off and check for binding, corrosion, or electrical switch defects. CAUTION: This step should be performed by an authorized service representative.
✔	✔	2) Conduct a hydro-test on the boiler and look for leaks at pipe joints and tube joints at the tube sheet. CAUTION: This step should be performed by a licensed boiler repair shop.
✔	✔	3) Inspect the waterside and perform cleaning operation. CAUTION: This step should be performed with the help of a licensed boiler repair shop. Replace all gaskets.
✔	✔	4) Tune up the burner settings. Clean nozzles. The amount of CO_2 present in the flue gas is an important measure of fuel efficiency of any burner. It should average about 10 percent for gas and about 12 percent for oil. Tune-ups are essential and will yield substantial fuel savings through increased efficiency. CAUTION: This step should be performed by an authorized service representative.
✔	✔	5) Inspect refractory for broken chunks that have fallen out.
✔	✔	6) Inspect the fireside and perform cleaning operation. Replace all caskets.
✔	✔	7) Check the gas regulator pressure setting. CAUTION: This step should be performed by an authorized service representative.
✔	✔	8) Inspect the boiler room combustion inlet screens and clean if necessary.
✔	✔	9) Make a safety relief valve pop test. CAUTION: This test should be made in accordance with instructions of the government boiler inspector or by a licensed repair shop or remove and have tested and reconditioned.
✔		10) Inspect boiler feed system.
✔	✔	11) Inspect chemical feed system.
✔	✔	12) Inspect system pumps.

Cleaning Boilers (S=Steam, W=Water)

Inadequate cleaning is a major cause of boiler failure. A number of steps are essential in keeping boilers clean. A need for cleaning usually is indicated when stack temperatures reach 150 deg. F. higher than steam or water temperature.

Fireside cleaning should be done during boiler lay up. Deposits from fuel, especially oil or coal fuel (such as sulphur, vanadium, and sodium) are corrosive and should be prevented or removed. Cleaning as follows for both steam and water boilers will restore efficiency (12 to 24 percent) and prevent corrosion: Clean both flue tubes and smokeboxes. Soot is removed with air or steam using soot blower jets.

Carbon is removed with tube scrapers or brushes.

Waterside cleaning: Impurities in water will form scale on metal surfaces and water treating compounds will form precipitates that settle out as sludge. Cleaning as follows restores efficiency (about 6 to 12 percent) and prevents hot spots and overheating.

S	W	
✔		• Blow down the boiler at a bottom drain to remove sludge.
✔		• Blow down the surface to remove grease and scum.
✔		• If blowdowns will not provide sufficient cleaning, boil out the boiler once or twice a year.
✔	✔	• If scale needs to be removed, have it done only by a licensed repair shop.
✔	✔	• Feedwater treatment and proper blowdown procedures are important to keep boiler surfaces free of scale to prolong boiler life. Feedwater consultants should be contacted to analyze the water and recommend treatment. Consultants also should recommend the blowdown procedure and frequency of blowdown to reduce concentration of impurities in the boiler.

boiler serviceman. The following repairs can generally be handled by the school custodial staff.

Leaks—Repair all leaks promptly. All piping connections to the boiler and accessories should be kept leak proof, because even a minor leak, if neglected, may soon become serious. This applies especially to water glass, water level control piping, handhole and manhole gaskets. If serious leaks occur, shut down the boiler immediately, gradually reducing pressure. Do not attempt to make repairs while the boiler is under pressure.

Covers and Inspection Plates—Repair leaky handhold or manhole covers by replacing worn gaskets. First, clean the metal surfaces where the cover plate bears against the shell plate. Next apply graphite paste or grease to the gaskets to prevent sticking and to make sure they are tight. Always use new gaskets. Make sure the cover plate and gasket are centered before drawing up bolts. Tighten bolts. As pressure is raised,

tighten these bolts repeatedly to make them leakproof.

Washout Plugs—Use the same method when renewing gasket or washout plugs. Grease the threads so the plug can be easily removed when necessary.

Water Gage Glass—When a water gage is broken, remove the pieces and slowly open the valves to blow out any remaining particles of broken glass. Before inserting the new glass, be sure it is the exact length required and that the connections line up. Otherwise it will break as it expands with the heat. Insert the new glass with rubber gaskets, brass rings, and stuffing box nuts. Take care not to set the nuts too tightly in order to allow for expansion from heat. Crack the top valve slightly to let steam flow through the glass to warm it gradually. Close drain cock and open bottom valves slowly. When water level is stable, open wide both top and bottom valves.

Gas and Oil Burners

An effective preventive maintenance program is absolutely essential to the safe, dependable, and efficient operation of fuel burning equipment. Preventable equipment failure—causing a boiler to overheat—is extremely expensive in terms of replacement equipment and days of school lost. In addition, a good maintenance program will result in more efficient fuel use and reduce energy costs.

Effective maintenance begins with knowledge of the equipment and how it should operate. Thus, preventive maintenance begins with these first steps:

1) Obtain two copies of the parts and service manual from the manufacturer. Data and instructions for allied equipment, such as combustion safety equipment and automatic valves, should be included in this book. If they are not provided, take steps to complete this manual by contacting the various manufacturers directly or asking the boiler manufacturer for them. One copy of the manual should remain in the boiler room and the other in an office file. Be certain that the wiring diagram, sequence of operation, the piping diagram showing valve train, and other necessary information for the particular installations are recorded in this manual.

2) Before attempting to maintain the burner, it is important to know exactly how the burner should operate. Obtain this information from the consulting engineer or the burner manufacturer, using the Burner Information form provided (see the Management Tools Appendix). This form should be put in the office files and the information recorded in the parts and service manual.

3) On a new installation, see that the maintenance team receives a demonstration of the burner operation by either the contractor or the burner manufacturer's representative. Be sure to get a clear and accurate explanation of every step of the burner operation and what precautions to take in the event the equipment fails to operate.

4) Obtain a recommended list of replacement parts from the burner manufacturer's representative and then determine what parts will be maintained in stock. Obviously, the distance and time from the source of supply are important factors in deciding what spare parts to stock.

5) Determine what service organization will be used. Record day and night telephone numbers, addresses, and other needed information near a light in the boiler room, as well as in the parts and service manual. This information should be readily available so that even a person unfamiliar with the burner operation could, in an emergency, call for service.

MAINTENANCE SCHEDULES

Once the operators are familiar with burner operations through both demonstration and reading of the parts and service manual, a maintenance schedule should be drawn up. The printed schedule should outline what is to be done and should be arranged so that each operation can be recorded and initialed by the operator doing the job. This will provide a permanent record of the daily service performed. The following services and frequencies are suggested:

Daily

1) Observe the burner operation as it goes through its various cycles, visually checking the

gas or oil pressure and either the steam pressure or hot water temperature.

2) Visually inspect the fire. In the case of oil, make sure that combustion is good and that smoke is not being produced. Any fire contact with the side walls of the boiler can form carbon deposits.

3) Keep the burner equipment, controls, and premises clean. If using fuel oil or any lubricating oil, visually check for leaks, determine cause, and correct promptly.

Weekly

Determine that each of the following controls is working properly:

- Operating control.
- High limit control.
- Electronic safety combustion control—simulate both main flame and pilot failures.
- High ambient temperature alarm.
- Alarm bells and lights.
- Emergency switch.
- Operation of both high and low gas pressure switches. (High gas pressure switch cannot be simulated; however, it may be disconnected electrically to be certain of its operation.)
- Thermal switch on a barometric damper, if used.
- Low oil pressure switch, if used. A clogged strainer, air leaks in the suction line system, or loose strainer cover will cause oil pump pressure to drop.
- Inspect the oil suction strainer. If the compound gage shows a higher vacuum than normal, this indicates that the strainer screen is obstructed with dirt, sludge, or wax.
- Lubricating oil level in compressor oil reservoir. Add oil if necessary.
- Make sure the recommended oil for compressor is used, not a substitute.

Monthly (Mainly for fuel oil systems)

1) Check conditions of the nozzle. Remove the nozzle unit or drawer assembly depending upon the type of burner, whether natural or forced draft type. If No. 2 oil is used, the nozzle should not require cleaning, but inspect it for carbon deposits. The heated oils, heavy Nos. 4, 5 and 6, may cause carbon deposits on the outside tips of the nozzle. Also, residue can collect in the inside mixer. Clean carefully. Do not use tools that will mar the machined surfaces, slots, or holes in both the inside and outside nozzle tips. Be careful to reassemble the nozzle correctly, and do not change the position of the diffuser or flame retention head.

2) On burners with diffuser or flame cone as part of the drawer assembly, remove any deposits that might have formed. If the burner housing or register has a hinged swing-out section, inspection can be made with the diffuser in place.

3) If the burner is a combination gas/oil type, be sure the gas orifices are free of any obstruction.

4) Check compressor operations, noting lubricating oil level and refilling it if required. Be sure the automatic sight flow indicators are clean and show rate of lubricating flow. Clean the sediment strainer in the oil supply line to the compressor. Rotary compressors may be furnished with the lubricating oil contained in a base reclaimer, overhead attached type or separately mounted. These use either suction or air pressure to force feed oil. Overhead suction reclaimer uses an automatic shutoff device to prevent oil flooding when the unit is not operating. Be sure the automatic oil feed valve is operating properly.

5) Reciprocating or piston type compressors requiring lubrication have the oil supply in the crank case. Add oil if the level indicator shows low oil. Some compressors may be the direct-connected oil-less type requiring no lubrication.

6) Compressors of all types are equipped with intake air filters which must be kept clean.

7) If the compressor is driven by "V" belt, wipe the belt clean and tighten if necessary. Follow the instruction manual.

8) Clean the dirt from the scale strainer screen mounted on the electric oil heater discharge and strainers in any other location in the supply line to the burner.

9) Lubricate the bearings on the burner jack shaft and all linkage that operates air louvers and fuel valves.

10) Note the operation of the oil pump, which may be either integral or remote. Noisy operation may indicate either clogged strainer causing high vacuum or air leaks in suction line or shaft seal causing low volume. Also, a low suction temperature when high viscosity oils are burned will cause pump noise.

11) If the oil pump is "V" belt driven, adjust it to the proper belt tension.

12) Inspect the electronic flame safeguard and

all motor starters, contactors, and relays. Clean all contacts with recommended cleaning fluid. Never use emery or sandpaper.

Semi-annually

1) With instruments, measure and record: stack temperature, CO_2, and electrical signal strength of the electronic flame safeguard system. On gas-fired burner, check CO_2; on fuel-oil burner, check smoke scale.

2) Check belts; tighten or replace as required. Oil or grease motors. Some motors do not require either grease or oil; others require it only once or twice a year. Follow the instructions of the motor manufacturer.

3) On oil systems, drain oil from compressor reservoir, flush out with light flushing oil, and replace with fresh oil.

Annually

1) Replace electronic tubes.

2) Replace electrodes and insulator in the gas electric ignition system.

3) On oil burners, check the oil filter and replace cartridges.

4) If the oil burning system is equipped with steam or hot water operated fuel oil heaters of the straight or bent tube type, they should be cleaned if required. Usually tubular oil heaters should not require cleaning the first year unless the oil heating capacity drops while all other conditions remain normal. First check operation and calibration of the steam oil temperature controls, because a heater may deliver oil at too low a temperature if a regulator is defective or out of adjustment. Steam capacity to the heater may be reduced by a clogged steam strainer ahead of the regulator. The steam trap may not operate properly, causing reduced heater efficiency, if its strainer is dirty or the float is not free to operate the condensate valve. If the trap valve does not open, the entire heater will become waterlogged; or if the trap valve remains open, live steam will be blowing through at all times. Some types of traps operate on the impulse principle without having a float mechanism.

5) Hot water oil heaters may be operated with gravity or forced flow hot water using a circulating pump controlled by an immersion temperature control. Be sure the pump and control are operating properly to maintain the established oil temperature.

6) If an electric heater is used on the burner, it should be drained to remove any sludge. After the first year, it would be well to remove the heater element once a year to clean out any heavy residue coating on the heater or the interior of the shell or manifold.

7) Have the service organization that is working on the burner check over the complete operation of the burner, tightening linkage and doing whatever is necessary to put the burner in first-class operation. This should be done either in late summer or early fall. Require a written report from the service organization as to what was done and the overall general condition of the burner.

Annual Inspection

Burners should be included in the annual inspection of heating and ventilating systems. See the Annual Inspection Checklist in the Management Tools Appendix.

Summer Shutdown

Assuming the burner is not used during the summer, it should be shut down as follows:

1) Shut all manual valves. These generally include the main line lubricated plug cock and the pilot line cock. It is not advisable to burn the pilot during the summer to keep the boiler dry. Moisture generated by combustion is usually greater than the condensation that occurs without a flame. If heat is necessary, an electric light bulb is preferable to a gas pilot.

2) Put the safety combustion control relay in the safety lock out position.

3) Put all disconnect switches relating to the gas burner in the off position; however, the equipment panel should be left on to maintain sufficient heat to remove the formation of moisture that may form within the panel.

4) The boiler section of this manual (page 146) contains more explicit steps that should be taken for summer shutdown.

SERVICING

Before attempting to troubleshoot, keep in mind that all servicing and adjustments to the burner should be performed only by qualified burner service personnel. Scheduled inspection and maintenance can be performed by the building maintenance team.

1) Make certain that the combustion chamber

and flues are purged of any unburned fuel before restarting the burner following any brief shutoff.

2) Always follow the burner operating sequence instructions in turning the burner on or off.

3) Always open disconnect switches before loosening or tightening the flame safeguard mounting or terminal screws.

4) Make certain that all electrical connections are secure, including the flame safeguard relay mounting connections.

5) Never oil any portion of the flame safeguard relay.

6) Unnecessary shutdowns may be prevented by the annual replacement of the flame safeguard vacuum tube (if used), periodic inspection to remove dust and dirt, and periodic checks of burner adjustments.

Maintenance personnel should be familiar with the burner system and all associated parts. An orderly way of checking for failures should be developed. In troubleshooting, maintenance men should keep in mind to start simple. Go on the assumption that the problem is minor, because in most cases it is. Do not look for complicated problems.

With the aid of a wiring diagram, a sequence of operation table and a voltmeter, first check at the source of power to ensure that the signal levels governing burner sequence are proper. Do not spend too much time in any one particular location of the circuit. Above all, recognize operator limitations. Operators can introduce additional problems to the burner if they are not thoroughly familiar with the sequence of operations and controls associated with it. Knowing his own limitations should tell the operator when to stop.

FAILURES

Upon detecting the cause of burner failure, correct it if possible. If the operator cannot correct the problem, but knows the cause of failure, inform the burner service company of the cause. This effort will save time and money. There are three primary ways to check the unit:

Sight—When performing daily inspection of the burner, note the appearance of the flame—color, shape, and the distance it is firing down the tube at low and high fire. If any changes occur, the maintenance man has a clue to possible trouble. For example, there may not be enough air for complete combustion. This could be the result of insufficient air makeup within the boiler room or the air linkage may be out of adjustment.

Sound—The burner should sound the same each time it lights and goes through its sequence of operations. Any detectable change could inform the operator of potential burner problems. For example, the burner should light with a smooth sounding start. If it huffs and puffs at the start, the cause might be venting blockage in the gas train, a pilot too small, too much air, or other problem.

Smell—If any unusual odors are detected, this may lead the operator to suspect that some of the flue combustible materials are leaking within the room. The cause of such a problem might be an insufficient amount of air for complete combustion, slippage on combustion air intake motorized dampers, leaking gaskets, or a similar problem.

The following should be done prior to calling the service organization:

1) Check to see if power is available to the burner.

2) If there is no power, check fuses, emergency switch, control switch, and summer-winter or heating standby switches. Reset all safety devices.

3) If there is a fuse-link switch located above the boiler, check to make sure it is functional. The burner may have gone off on high temperature.

4) Check the low water cutoff; some have manual reset.

5) Check the high limit pressuretrol or high limit water thermostat or temperature controls associated with the burner. Many of these have a manual reset and may have been tripped due to burner conditions.

6) High/low gas pressure switches have manual reset switches. They may have been tripped by unusual gas conditions within the area.

7) Check gas cocks and burner fuel supply.

8) Check the flame safeguard for safety shutdown and lockout.

9) Visually inspect the sequencer, internal fuse, tubes, and flame scanner.

10) Check the low fire start switch on the burner.

11) Check the combustion air damper motor and the end switch.

12) Check the thermo switch associated with

the barometric damper if the system has one.

13) Check the inducted draft fan and associated fuses. Check for broken belts, burned out motor, etc.

14) Check burner motor overloads on the starter and panel or on the motor itself.

On completion of the basic checks listed above, note which safety had the unit off and correct the failure. If none of the above can be picked as the cause of the problem, call the service organization that normally maintains the burner equipment and advise them of the steps taken.

Chillers

Annual Shut-Down Maintenance

1) Check unit thoroughly for refrigerant leaks.
2) Check compressor motor resistance.
3) Tighten motor terminals and control panel terminals.
4) Inspect safeties for proper mounting.
5) Check crankcase heater for proper operation.
6) Visually inspect condenser tubes (if applicable).
7) Check condition of control contacts for wear, pitting, and erosion.
8) Inspect strainers and clean as required.
9) Check the alignment of open-motor drive units.
10) Provide a written report of work completed and indicate all detected deficiencies.
11) Air-cooled items:
- Inspect condenser fans.
- Inspect condenser coils.
- Lube condenser fan motors and bearings as required.
- Inspect outside coils for dirt and brush clean as required. (Wash coils once per year, or as required.)

Seasonal Start-up

1) Check auxiliary equipment operation and interlocks.
2) Start the condenser water pump and water tower (if applicable).
3) Start the chilled water pump.
4) Start the chiller.
5) Measure voltages, amperages, operating temperatures, refrigerant pressures, and superheat of the chiller.
6) Check for proper refrigerant and oil levels.
7) Check all safety and monitoring controls and verify operation.
8) Verify that unit controller and other controls operate properly.
9) Verify that unloaders operate properly (if applicable).
10) Log operating conditions on owner's log.
11) Provide a written report of work completed and indicate all detected deficiencies.
12) For air-cooled units inspect outside coils for dirt and brush clean as required. Verify condenser fans operate properly and have the proper mounting integrity. Lube as required.

Seasonal Inspection

1) Check operation of the chiller.
2) Verify operation of the auxiliary equipment.
3) Check electrical wiring, motors, and electrical components for proper operation.
4) Check operation of the control circuit and unloaders.
5) Check for proper refrigerant and oil levels.
6) Perform routine maintenance as required.
7) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Brush clean condenser tubes.
2) Eddy current testing.
3) Refrigerant analysis.

Cooling Towers

Start-Up

1) Remove all debris from within and around unit.
2) Clean water sump and verify its integrity.
3) Clean float valve assembly and adjust for proper operation.
4) Check and clean bleed-off line and overflow system.
5) Clean tower spray nozzles and eliminators.
6) Inspect fans and fan assemblies.

7) Oil or lube fan and motor bearings as required.
8) Check oil in gear reducer and change oil if required.
9) Inspect belts and alignment. Change belts as required.
10) Inspect wiring and electrical components.
11) Inspect baffles.
12) Clean tower strainers.
13) Check sump heaters and thermostats for calibration and operation if applicable.
14) Check and adjust condenser water temperature regulator system.
15) Have water treatment system checked by technician.
16) Place tower in operation and verify tower operates as required.
17) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Inspection

1) Clean debris from sump if required.
2) Check operation of float assembly.
3) Inspect tower spray nozzles and eliminators.
4) Inspect fans and fan assemblies.
5) Check oil in gear reducer.
6) Inspect belts and change as required.
7) Verify that tower operates properly.
8) Check and clean bleed-off line and overflow system.
9) Clean tower strainers.
10) Check sump heaters and thermostats for calibration and operation if applicable.
11) Check and adjust condenser water temperature regulator system.
12) Have water treatment system checked by technician.
13) Provide a written report of work completed and indicate all detected deficiencies.

Shut-Down

1) Shut down tower.
2) Drain sump as required.
3) Drain piping as required.
4) Shut off all water connections.
5) Turn off equipment power.
6) Perform routine maintenance as required.

Water Treatment

Water for heating, cooling, and other uses generally comes from underground or surface water sources and usually contains impurities.

These impurities are usually classified as dissolved solids, dissolved gases, or suspended matter. Water is a universal solvent. Almost all substances will partially dissolve in it. To some degree water will dissolve rock, soil, and many metals. It will absorb gases, including air and gases formed by organic decomposition.

In general, underground waters are consistent relative to composition, temperature, and hardness. They usually contain less suspended matter and turbidity than surface waters.

The vast amount of water available and its tremendous capacity for absorbing, releasing, and storing heat make it ideal for use in heating and cooling. Before using any water, however, the impurities must be removed or controlled by water treatment.

THE CHEMISTRY OF WATER

A few basic facts regarding the chemistry of water might be helpful.

The pH (chemists' abbreviation for the degree of acidity or alkalinity) of water is a delicate balance between hydrogen ions (H+) and hydroxide ions (OH-). When the hydrogen ion (H+) predominates, the water is acidic. If the hydroxide ion (OH-) predominates, the water is alkaline. The decree of acidity or alkalinity is determined by the relative amounts of H+ and OH- ions. This degree of alkalinity or acidity is based on a scale of 0 to 14. Above pH 7, water is considered alkaline; below 7 it is considered acidic. At pH 7, water is considered neutral, but it is aggressive.

The alkalinity of water is influenced by hydroxide ions and by carbonate and bicarbonate ions. When water is tested for alkalinity, test for the combined amounts of hydroxide, carbonate, and bicarbonate ions. This amount is normally reported as ppm (parts per million) or mg/l (milligrams per liter) calcium carbonate. When testing for pH, measure the relative amount of hydrogen and hydroxide ions present.

Some waters contain calcium and magnesium salts in great abundance. The amounts of these particular impurities constitute the hardness of the water. They make water difficult to wash with

because they react with soap to form a curd. Like alkalinity, the hardness is reported in grains, ppm or mg/l calcium carbonate.

There are many other factors which influence the chemistry of water, but these are the basic ones.

WATER BOILERS

Water boilers are perhaps the easiest to treat. A treatment which has been found to work well is to add baking soda to achieve and maintain a pH of 8.5 to 9.5. The pH of the boiler water should he tested monthly to determine if it is in the proper range. Lower pH may produce corrosion on the water side of the boiler. Add borate or sodium hydrofide as needed.

Where high pH is not practical, molybdate, nitrite, azole with borate or hydrofide can be used as corrosion inhibitors. The discharge of these chemicals to a sewer could disrupt a sewage treatment plant and cause it to pollute the natural waters. Therefore, their use should be minimized.

pH can be tested by using pH indicator paper available from any laboratory supply company. The school chemistry laboratory may have a pH meter. If so, use it.

The boiler should he flushed and refilled as required to remove sediment. Be sure to bring the pH back to 8.5 to 9.5 after refilling.

STEAM BOILERS

The water treatment program best suited to any steam boiler system depends upon the amount of make-up water needed by that system. The primary objective of any steam boiler system is to keep the amount of make-up (fresh water added to the system) to the minimum required by the system. Doing this conserves energy needed to heat the fresh water, reclaims the maximum amount of valuable pure water (condensate), minimizes water treatment chemicals required, minimizes make-up water pretreatment (softeners, de-aerators, etc.), and keeps the boiler treatment and blowdown program as simple as possible.

Most school boilers are designed as low make-up boilers used for building heat only. Intentional steam losses for such areas as humidification are relatively rare. Unintentional steam/condensate losses are very costly and should be immediately repaired. This includes leaking traps causing steam losses through vents at the condensate receivers.

Steam/condensate losses in a steam system are especially wasteful as the hot, distilled water being lost has to be replaced by cold, contaminated makeup water.

Some boiler blowdown and make-up water additions, however, are necessary in all types of steam boiler systems. Control lines (such as low water cut-offs) should be briefly blown down to keep them operating safely. In addition, the boilers should be blown down from the lowest opening to remove sediment.

The treatment of steam boilers amounts to the control of (1) boiler deposits, (2) corrosion, and (3) foaming.

The main source of boiler deposits is the dissolved minerals contained in hard water. These deposits are generally classified as scale or sludge (mud). The term scale is used to describe the deposits which adhere to boiler water surfaces. The deposits which do not adhere (drop off) are called sludge. The purpose of boiler treatment (amines) is to chemically change dissolved minerals which will form scale in the boiler to an inert form of sludge which can be removed from the boiler by blowing down or flushing.

The treatment of mineral matter (hardness) in the feed water can be handled by external softening or internal softening. Water is softened externally prior to entering the boiler by installing a softening system, such as a sodium zeolite or lime softening system.

Hardness can be removed internally by adding to the boiler water one of the sodium phosphates listed below:

Mono-sodium phosphate, anhydrous
Mono-sodium phosphate
Di-sodium phosphate, anhydrous
Di-sodium phosphate
Tri-sodium phosphate
Sodium meta-phosphate
Tetra sodium hypo-phosphate

Carbonate or hydrofide should be added to phosphate for hard water. A polymer sludge conditioner may be required.

The phosphate level should be maintained at 30 to 60 ppm. This results in zero hardness of your boiler water.

In the past few years another treatment for hardness has proved successful. This treatment uses chelates such as EDTA to modify complex calcium ions and magnesium ions so they are harmless to the system. However, this system requires daily testing and excellent softener control to be effective.

Corrosion in boilers is usually caused by dis-

solved oxygen reacting with iron in the boiler and by carbonic acid, which is produced when carbon dioxide dissolves in water.

Dissolved oxygen can be removed externally with mechanical de-aerators. Some type of chemical internal removal should also be used, however. Internal dissolved oxygen is removed by the addition of sodium sulfite (oxygen scavenger). A level of 30 to 60 ppm sulfite should be maintained in the boiler at all times.

Carbon dioxide is removed by creating an environment in which it cannot exist. This is handled by adding neutralizing amines to the boiler water to produce a pH of 10.5 to 11.2. Once a pH level of 10.5 is established, it will normally remain in the proper range. If the pH exceeds 11.2, the danger of caustic embrittlement of the boiler metal exists. If this high pH occurs, quickly drain and flush the boiler, refill, treat with chemicals and resume operation.

Foaming and/or priming in a boiler are usually caused by oil or excessive solids (dissolved or suspended) in the boiler water. If the problem is caused by oil, the source of the oil should be located and eliminated. The dissolved solid levels in the boiler are controlled by blowdown. The only measurement of blowdown adequacy is the chloride level in the boiler water. A chloride level of 80 to 100 ppm normally indicates adequate blowdown, depending on makeup water characteristics. (Conductivity or alkalinity can be used as limiting criteria.) Higher chloride levels indicate insufficient blowdown and that solids may be high enough to cause foaming.

There is a simple test to determine if a steam boiler is foaming or priming. Build up a reasonable load of steam in the boiler and then very slowly open the safety valve on the boiler. If water is discharged through the safety valve, the boiler is priming or foaming, and the oil or solids must be removed. CAUTION: The water which is discharged by the safety valve is scalding hot; stand clear of the valve and the water stream.

Foaming can usually be controlled by increasing blowdown.

Oil can be removed from a boiler by using Sal Soda as follows:

1) Completely drain the boiler from all low points to remove all possible sediment.

2) Add water and Sal Soda to the boiler until it is filled to the proper operating level. Use Sal Soda at the rate of 5 to 10 pounds per 100 gallons of boiler water.

3) Gradually heat boiler water. All air and steam should be carefully vented to the atmosphere.

4) Continue to heat the boiler water, and when the water becomes hot, slowly add additional fresh water to overfill the boiler through the highest available opening to remove any oil deposits which float on the water surface.

5) Maintain the water at boiling for at least an hour and then slowly drain the water completely.

6) Refill the boiler with water and again overfill it. Again heat the water to boiling and completely drain again.

7) It may be necessary to repeat steps (2) to (6) several times to fully clean the boiler and step (6) two or three times to completely remove all traces of Sal Soda.

8) Refill the boiler to the normal water level and add required treatment chemicals.

In high pressure boilers, the breakdown of bicarbonates in the boiler water can form free carbon dioxide (CO_2), which will leave with the steam to the system. In turn, this free CO_2 forms corrosive carbonic acid when it dissolves in the water in the return lines, producing vigorous corrosion. This corrosion of the condensate lines can be controlled by using filming amines, such as octadecylamine or octadecylamine acetate, introduced into the boiler water. However, these amines are hard to control and require extensive feed equipment. Neutralizing amines such as marpholine or cyclohexylamine can also be used.

Ideally, boiler water should be tested at least weekly for the following:

Test	Desired Concentration
pH	10.5 to 11.2
Hardness	Less than 1 ppm
Sulfite	30 to 60 ppm
Phosphate	30 to 60 ppm
Alkalinity	(2P - M = OH)
P	400 to 800 ppm
M	under 1000 ppm
OH	over 200 ppm

If these levels are maintained, boiler operation can be efficient and at lowest cost.

Sulfites should be fed to condensate return tank. Other chemical additions can be made directly to the condensate return tank in powder or liquid form at least weekly. Ideally they should be added continuously by a proportional feed pump connected to the boiler feed pump dis-

charge line between the boiler feed pump and the boiler. It should be activated when the boiler feed pump is operating.

Improperly treated boilers may require manual or chemical removal of scale deposits. Chemical cleaning is difficult and dangerous. It should only be attempted by experienced personnel. Manual cleaning is expensive.

COOLING TOWER WATER

The treatment of cooling tower water involves the control of (1) microbiological deposits, (2) scale deposits, (3) corrosion, (4) mud and other deposits, (5) foam. Cooling tower water treatment recently has become a problem because of the potential pollution hazard of treatment chemicals.

Seek a treatment which is effective, yet non-polluting. The best solution is the service of a reputable chemical treatment company. They will evaluate the system and provide an effective non-polluting type of chemical treatment. Many treatments of this type are available but they must be suited to a particular system.

CHILLER WATER

Chiller protection by chemical treatment is necessary for efficient operation. These systems are delicate and must be treated properly at all times.

The best treatment is the addition of 2 or 3 ppm of sodium chromate to the chiller water. This concentration must be checked at least monthly to determine if more chromate must be added to maintain the proper 2 to 3 ppm concentration.

DOMESTIC HOT WATER

The most common problem encountered in domestic hot water systems is the corrosion of pipes by extremely soft water. The softening system should maintain a safe hardness level of 4 to 5 grains per gallon (80 to 120 ppm total hardness). It should be tested regularly for hardness.

Where water of 0 to 2 ppm total hardness is required for the boiler, hard water should be blended with the soft water to achieve 80 to 120 ppm total hardness serving the rest of the building.

Another common problem is the scaling of pipes. Control can usually be accomplished by the use of sodium phosphates, sodium silicate, or a combination of the two. Additions should be made with a proportional feed pump/water meter combination. The chemicals used must be approved for human consumption and must be mixed and dispensed under hygienic conditions. (The Food and Drug Administration prescribes a limit of 10 ppm orthophosphate.)

Air Handling Units

An air handling unit generally consists of a centrifugal fan, heating and/or cooling coils, filter box, fan motor, and belt drive. It may be controlled by cycling the fan from the thermostat. Usually, however, the fan runs continuously with heating/cooling capacity modulated by face and bypass dampers or valve controls on the heating/cooling medium. The fan section may discharge into conventional ductwork or into a plenum with grilles.

Below and on following pages are suggested schedules for inspecting and maintaining air handling units for four common configurations:

- Split system air handling units;
- Split system air handlers with condensing units;
- Air handlers with heating sections;
- Air handlers with DX cooling coils.

For fan maintenance, see the check lists provided in the section on Fan and Furnace Inspections (page 170).

Spare belts should be stocked. If a drive uses multiple belts, the belts should be stocked in matched sets and the complete set of belts replaced at one time. If belt life is shorter than expected, recheck alignment and tension. It is normal for belts to squeal on start-up; do not over tighten just to eliminate this initial squealing.

When checking or servicing motors, drives, or fan wheels, be sure the motor disconnect is open and tagged so other personnel will not restart the unit. Be careful near belt drives when belt guard is removed for service. Do not wear loose clothing or neckties when working near exposed drives.

Air handling units often draw in large quantities of outside air. The amount of outside air depends upon the adjustment and alignment of

the outside air dampers. Insure that these dampers close and seat properly, so that excess outside air quantities are not heated and cooled due to improper damper adjustment or leakage.

INSPECTING AND MAINTAINING SPLIT SYSTEM AIR HANDLERS

Seasonal Cooling Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.
2) Verify that thermostat operates properly.
3) Inspect safeties for proper mounting and operation.
4) Inspect fan wheels.
5) Inspect shaft and motor bearings.
6) Verify proper pulley alignment.
7) Inspect belts and replace as required.
8) Lube all motors and bearings.
9) Brush clean coils. (Wash coils once per year if needed.)
10) Brush clean fan wheel as required.
11) Inspect filters and clean as required. (Replace filters if non-cleanable type.)
12) Clean drain pan and verify proper water drainage through condensate piping system.
13) Check external interlocks for proper operation.
14) Inspect unit cabinet for proper integrity.
15) Measure voltage and amperage of evaporator fan motor.
16) Place system in operation and measure temperature drop across coil.
17) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Cooling Inspection

1) Verify that unit controller operates properly.
2) Check operation of the control circuit.
3) Verify operation of the fan.
4) Check condition of electrical wiring and operation of electrical components.
5) Measure the temperature drop across the coil.
6) Perform routine maintenance as required including changing filters and performing required lubrication.
7) Inspect belts for proper condition and alignment within pulleys.
8) Brush clean coils as required.
9) Provide a written report of work and indicate detected deficiencies.

Seasonal Heating Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.
2) Verify that thermostat operates properly.
3) Inspect safeties for proper mounting and operation.
4) Inspect fan wheels.
5) Inspect shaft and motor bearings.
6) Verify proper pulley alignment.
7) Inspect belts and replace as required.
8) Lube all motors and bearings.
9) Brush clean coils. (Wash coils once per year if needed.)
10) Brush clean evaporator fan wheel as required.
11) Inspect filters and clean as required. (Replace filters if non-cleanable type.)
12) Check external interlocks for proper operation.
13) Inspect unit cabinet for proper integrity.
14) Measure voltage and amperage of evaporator fan motor.
15) Place system in operation and measure temperature rise through unit.
16) Provide a written report of work completed and indicate all detected deficiencies.
17) Gas Heat Routine:
- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold.
- Inspect flame condition.
- Verify integrity of the flue system.

18) Electric Heat Routine:
- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

19) Hot Water/Steam Routine:
- Inspect control valves and traps.
- Check and verify operation of operating and safety controls.
- Verify operation of heating coils.
- Brush clean coils as required.

Seasonal Heating Inspection

1) Check operation of the unit.
2) Verify operation of the fan.
3) Check condition of electrical wiring and operation of electrical components.
4) Check operation of the control circuit.
5) Perform routine maintenance as required including changing filters and lubrication.
6) Inspect belts for proper condition and alignment within pulleys.
7) Brush clean coils as required.
8) Verify proper operation of the heating section.
9) Check and verify operation of heating section safeties.
10) Verify that heating energy source meets unit's requirements.
11) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Verify operation of economizer system.
2) Perform required maintenance and check operation of inlet-guide-vane system.
3) Verify proper operation of the fan speed controller.
4) Verify proper operation of the multi-zone damper system.

INSPECTING AND MAINTAINING SPLIT SYSTEM CONDENSING UNITS

Seasonal Start-up

1) Check condition of control contacts for wear, pitting, and erosion.
2) Tighten motor terminals and control panel terminals.
3) Inspect safeties for proper mounting.
4) Verify operation of the evaporator air side.
5) Place the unit in operation.
6) Measure voltages, amperages, operating temperatures, superheat, and refrigerant pressures of the unit. Check for voltage imbalance.
7) Check for proper refrigerant charge and oil levels.
8) Check and verify operation of safety controls and unloaders.
9) Verify that thermostat operates properly.
10) Lube all motors and bearings as required.
11) Inspect belts and change as required.
12) Inspect all fan brackets and motor supports for proper integrity.
13) Inspect outside coils for dirt and brush clean as required. (Wash coils once a year or as required.)
14) Verify that all fans operate properly in response to controllers.
15) Check crankcase heater for proper operation.
16) Check external interlocks for proper operation.
17) Inspect unit cabinet for proper integrity.
18) Log operating conditions.
19) Inspect refrigerant piping for leaks.
20) Inspect refrigerant piping insulation for defects.
21) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Inspection

1) Check operation of the unit.
2) Verify operation of the evaporator air side.
3) Check condition of electrical wiring and operation of electrical components.
4) Check operation of the control circuit and unloaders.
5) Check for proper refrigerant and oil levels.
6) Perform routine maintenance as required.
7) Inspect belts for proper condition and alignment within pulleys as required.
8) Verify that all fans operate properly in response to controller.
9) Brush clean outside coils as required.
10) Verify crankcase heater operation.
11) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Verify proper operation of the fan speed controller.
2) Verify proper operation of the low-ambient damper.

INSPECTING AND MAINTAINING AIR HANDLERS WITH HEATING SECTION

Seasonal Heating Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.
2) Verify that thermostat operates properly.
3) Inspect safeties for proper mounting and operation.
4) Inspect fan wheels.
5) Inspect shaft and motor bearings.
6) Verify proper pulley alignment.
7) Inspect belts and replace as required.

8) Lube all motors and bearings.
9) Brush clean fan wheel as required.
10) Inspect filters and clean as required. (Replace filters if non-cleanable type.)
11) Check external interlocks for proper operation.
12) Inspect unit cabinet for proper integrity.
13) Measure voltage and amperage of supply air fan motor.
14) Place system in operation and measure temperature rise through unit.
15) Provide a written report of work completed and indicate all detected deficiencies.
16) Gas Heat Routine:
- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold.
- Inspect flame condition.
- Verify integrity of the flue system.

17) Electric Heat Routine:
- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

18) Hot Water/Steam Routine:
- Inspect control valves and traps.
- Check and verify operation of operating and safety controls.
- Verify operation of heating coils.
- Brush clean coils. (Wash coils once per year if needed.)

Seasonal Heating Inspection

1) Check operation of the unit.
2) Verify operation of the supply air fan.
3) Check condition of electrical wiring and operation of electrical components.
4) Check operation of the control circuit.
5) Perform routine maintenance as required including changing filters and lubrication.
6) Inspect belts for proper condition and alignment within pulleys.
7) Brush clean coils as required.
8) Verify proper operation of the heating section.
9) Check heating section safeties.
10) Verify that the heating energy source meets unit's requirements.
11) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Perform required maintenance and check operation of inlet-guide-vane system.
2) Verify proper operation of the fan speed controller.
3) Verify proper operation of the motor-operated outside-air accessory.

INSPECTING AND MAINTAINING AIR HANDLERS WITH DX COOLING COILS

Seasonal Cooling Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.
2) Verify that thermostat operates properly.
3) Inspect safeties for proper mounting and operation.
4) Inspect fan wheels or blades.
5) Inspect shaft and motor bearings.
6) Verify proper pulley alignment.
7) Inspect belts and replace as required.
8) Lube all motors and bearings.
9) Brush clean coils. (Wash coils once per year if needed.)
10) Brush clean fan wheel as required.
11) Inspect filters and clean as required. (Replace filters if non-cleanable type.)
12) Clean drain pan and verify proper water drainage through condensate piping system.
13) Check external interlocks for proper operation.
14) Inspect unit cabinet for proper integrity.
15) Measure voltage and amperage of evaporator fan motor.
16) Place system in operation and measure temperature drop across coil.
17) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Cooling Inspection

1) Verify that thermostat operates properly.
2) Check operation of the control circuit.
3) Verify operation of the evaporator fan.
4) Check condition of electrical wiring and operation of electrical components.

5) Measure the air temperature drop across the coil.

6) Perform routine maintenance as required including changing filters and performing required lubrication.

7) Inspect belts for proper condition and alignment within pulleys.

8) Brush clean coils as required.

9) Provide a written report of work and indicate detected deficiencies.

10) Chilled water cooling coils:
- Verify automatic valve operates properly.
- Clean strainer.

11) DX cooling coils:
- Verify liquid pressure and suction pressure and temperature.
- Verify that expansion valve operates properly.
- Verify refrigerant charge is proper.

Seasonal Heating Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.

2) Verify that thermostat operates properly.

3) Inspect safeties for proper mounting and operation.

4) Inspect fan wheels.

5) Inspect shaft and motor bearings.

6) Verify proper pulley alignment.

7) Inspect belts and replace as required.

8) Lube all motors and bearings.

9) Brush clean coils. (Wash coils once per year if needed.)

10) Brush clean fan wheel as required.

11) Inspect filters and clean as required. (Replace filters if non-cleanable type.)

13) Check external interlocks for proper operation.

14) Inspect unit cabinet for proper integrity.

15) Measure voltage and amperage of evaporator fan motor.

16) Place system in operation and measure temperature rise through unit.

17) Provide a written report of work completed and indicate all detected deficiencies.

18) Gas Heat Routine:
- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold.
- Inspect flame condition.
- Verify integrity of the flue system.

19) Electric Heat Routine:
- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

20) Hot Water/Steam Routine:
- Inspect control valves and traps.
- Check and verify operation of operating and safety controls.
- Verify operation of heating coils.
- Brush clean coils as required.

Seasonal Heating Inspection

1) Check operation of the unit.

2) Verify operation of the evaporator fan.

3) Check condition of electrical wiring and operation of electrical components.

4) Check operation of the control circuit.

5) Perform routine maintenance as required including changing filters and lubrication.

6) Inspect belts for proper condition and alignment within pulleys.

7) Brush clean coils as required.

8) Verify proper operation of the heating section.

9) Check and verify operation of heating section safeties.

10) Verify that the heating energy source meets unit's requirements.

11) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Verify operation of economizer system.

2) Perform required maintenance and check operation of inlet-guide-vane system.

3) Verify proper operation of the fan speed controller.

4) Verify proper operation of the multi-zone damper system.

Packaged Rooftops Units

Packaged rooftop air conditioning equipment consists of a complete factory package containing both heating and cooling facilities. The package may be a single-zone system serving only one area, or a multi-zone system serving several areas at the same time.

The major cooling components are the refrigeration compressor, evaporator (cooling) coil, and air cooled condenser coil. The heating sections vary depending upon the heat source—gas, oil, or electricity. Some units may use hot water or steam piped from a central boiler.

Each manufacturer has specific instructions on how to adjust and care for the various components of the equipment. Special tools and training are necessary in order to make certain repairs and to perform certain maintenance checks. However, most of the important checks and maintenance services should be made regularly by the school maintenance team. All that is required is alertness during specific routine inspections. The Maintenance Checklist for Rooftop Air Conditioning in the Management Tools Appendix will help in scheduling and carrying out the maintenance program. The following is what can and should be done on a routine basis.

Seasonal Cooling Start-Up

1) Check condition of control contacts for wear, pitting, and erosion.

2) Tighten motor terminals and control panel terminals.

3) Inspect safeties for proper mounting.

4) Verify operation of the evaporator air side.

5) Place the unit in operation.

6) Measure voltages, amperages, operating temperatures, superheat, and refrigerant pressures of the unit. Check for voltage imbalance.

7) Check for proper refrigerant and oil levels.

8) Check and verify operation of controls and unloaders.

9) Verify that thermostat operates properly.

10) Lube all motors and bearings as required.

11) Inspect belts and change as required.

12) Inspect all fan brackets and motor supports for proper integrity.

13) Verify proper alignment of pulleys.

14) Inspect inside and outside coils for dirt and brush clean as required. (Wash coils once a year as required.)

15) Brush clean fan wheels as required.

16) Verify that all fans operate properly in response to controllers.

17) Inspect filters and clean as required. (Replace filters if non-cleanable type.)

18) Clean drain pan and verify proper water drainage through condensate piping system.

19) Check crankcase heater for proper operation.

20) Check external interlocks for proper operation.

21) Inspect unit cabinet for proper integrity.

22) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Cooling Inspection

1) Check operation of the unit.

2) Verify operation of the evaporator air side.

3) Check condition of electrical wiring and operation of electrical components.

4) Check operation of the control circuit and unloaders.

5) Check for proper refrigerant and oil levels.

6) Perform routine maintenance as required including changing filters and required lubrication.

7) Inspect belts for proper condition and alignment within pulleys.

8) Verify that all fans operate properly in response to controller.

9) Brush clean coils as required.

10) Verify crankcase heater operation.

11) Provide a written report of work and indicate detected deficiencies.

Seasonal Heating Start-Up

1) Verify operation of the evaporator air side.

2) Inspect belts and change as required.

3) Inspect all fan brackets and motor supports for proper integrity.

4) Verify proper alignment of pulleys.

5) Inspect inside and outside coils for dirt and brush clean as required. (Wash coils once a year as required.)

6) Verify that all fans operate properly in response to controllers.

7) Inspect filters and clean as required. (Replace filters if non-cleanable type.)

8) Check and verify operation of safety controls for heating section.

9) Verify that thermostat operates properly.

10) Lube all motors and bearings as required.

11) Verify that all fans operate properly.

12) Check operation of heating control circuit including interlocks.

13) Inspect safeties for proper mounting.

14) Place heating section in operation.

15) Measure temperature rise through heating section.

16) Gas Heat Routine:

- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold (if applicable).
- Inspect flame condition.
- Verify integrity of the flue system.

17) Electric Heat Routine:

- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

18) Hot Water/Steam Routine:

- Inspect control valves and traps.
- Check and verify operation of operating and safety controls.
- Verify operation of heating coils.
- Brush clean coils as required.

19) Provide a written report of work and indicate detected deficiencies.

Seasonal Heating Inspection

1) Check operation of the unit.

2) Verify operation of the evaporator air side.

3) Check condition of electrical wiring and operation of electrical components.

4) Check operation of the control circuit.

5) Perform routine maintenance as required including changing filters and lubrication.

6) Inspect belts for proper condition and alignment within pulleys.

7) Verify that all fans operate properly.

8) Brush clean coils as required.

9) Verify proper operation of the heating section.

10) Check and verify operation of heating section safeties.

11) Verify that heating energy source meets unit's requirements.

12) Provide a written report of work completed and indicate all detected deficiencies.

Options

1) Verify operation of economizer system.

2) Perform required maintenance and check operation of return fan system (belts, lubing, bearings, fan wheel, brush cleaning).

3) Perform required maintenance and check operation of inlet-guide-vane system.

4) Verify proper operation of the fan speed controller.

5) Verify proper operation of low-ambient damper.

Unit Ventilators

Unit ventilators can heat and ventilate. Some units can also air condition. All unit ventilators make use of outdoor air whenever practical to achieve proper comfort conditions. They provide a minimum amount of outdoor air during occupied periods to meet health code requirements. Greater than minimum amounts are provided during those periods when natural atmospheric "free cooling" can overcome internal heat gains within a room when those heat gains are in excess of heat loss.

A unit ventilator will heat an area to a desired temperature as called for by the room thermostat and will maintain that temperature by allowing a mixture of outdoor air and recirculated room air to discharge into the room. This is done by means of dampers and/or valves. The required room temperature is maintained by the room thermostat and an air stream thermostat. One works with the other to control the discharge air temperature coming out of the unit ventilator so the room will remain at the constant temperature called for by

the room thermostat.

At start-up time in the morning, the discharge air coming out of the unit ventilator will be hot in order to bring the room air up to the desired temperature. As soon as the room is occupied, the temperature of the discharge air will go down to a point sufficient to take care of the heat loss of the room. In addition, a minimum amount of outdoor (ventilation) air is also delivered to the room. After the room has been occupied for a time, the discharge temperature generally drops below the thermostat setting, because the combined heat given off by the students, the lights, and the sun is more than the heat loss of the room. To maintain the desired temperature, it is therefore often necessary for the controls to provide cooling by introducing additional outside air beyond the minimum amount. This is done by means of dampers and/or valves in the unit ventilator.

HEATING SYSTEMS

There are four basic types of heating systems available for use with unit ventilators: steam, hot water, gas (direct fired) and electric.

Steam unit ventilators are controlled by a valve on the heating coil supply line and a damper motor on the outdoor air and return air dampers. The steam unit ventilator has a trap on the return line of the coil. This is either a thermostatic trap or a float and thermostatic trap.

Hot water unit ventilators are divided into two classes: valve controlled and damper controlled. The valve controlled unit has a supply valve similar to the steam unit. It also has a damper motor operating the outdoor air and return air dampers. The control valve generally is a three-way valve that, when closed, bypasses water around the coil. The damper controlled unit generally does not have a control valve. It has a third damper inside the unit, which is called a bypass damper. The coil has water circulating through it at all times, and temperature control of the discharge air is accomplished by movement of the bypass damper. This allows the proper percentage of air to go through the coil while the balance of the air bypasses the coil. When mixed, this air is then at the proper temperature for the desired room condition.

Gas fired units were used when a central heating plant was undesirable or unavailable. These units are no longer manufactured. These units were equipped with outdoor air and return air dampers. Combustion air came from the room or from an outside inlet. In some buildings, a unit was installed in each room; in others, a small furnace room serviced two adjoining rooms. The operation and control of these units is similar to the steam unit except that in place of the coil, there is a heat exchanger with a gas burner that goes on or off to maintain room temperature.

Electric unit ventilators are becoming more common. The basic operation is similar to the steam unit, except that an electric coil controlled by a step controller is used in place of a steam coil. The individual elements of the electric coil come on in steps. For partial heating, therefore, only part of the elements are used.

Maintenance Schedule for Unit Ventilators

Caution: Gas fired burners, electric elements, temperature controls, and refrigeration systems (chiller or direct expansion) should be serviced only by competent individuals trained to work on those systems.

Monthly

1) Listen for unusual motor or drive noises that would indicate a bearing problem

2) Check filters: clean or replace as necessary. Make sure to clean both filters if two are used. Second filter will be behind the first one and may not be easily visible.

3) Inspect wall intake box to see that it is free of leaves and debris.

Semi-Annually

1) Inspect interior of the unit and clean as needed. Pay particular attention to entering air face of heating/cooling coil for dirt or lint.

2) Check damper linkages and control mountings to insure proper positioning and alignment. See that the outside air damper closes properly and seals tightly.

3) Inspect belts if the unit is belt driven. Replace belts if badly frayed or cracked. Check alignment of the drive.

4) Lubricate motors and fan shafts as indicated on the unit nameplate.

5) Inspect traps and control components for proper operation.

Annually

Include unit ventilators in an annual equipment inspection. See the Heating and Ventilating Systems Inspection Checklist in the Management Tools Appendix.

AIR CONDITIONING SYSTEMS

Two basic types of air conditioning are found in unit ventilators: direct expansion and chilled water. Both types may occasionally be found in a "future" configuration where provisions for adding air conditioning at a later date were made at the time of original installation. Both types include insulation and a drain pan which is piped to a condensate disposal system.

Direct expansion type units are further divided into two classes: remote condensing unit and self-contained.

The remote condensing unit type system (split system) uses a small two- to five-ton condensing unit located outside near the unit ventilator it serves.

The self-contained type is a completely self contained system within a single cabinet and must be located on an outside wall. All direct expansion type units do not require a seasonal changeover and, therefore, exact comfort conditions are available at all times.

Chilled water type air conditioning units are available in two classes: two pipe and four pipe. Both use a piped central chiller plant with accompanying air cooled condenser or cooling tower. The two-pipe version uses the same coil as described under the "hot water-damper controlled" section except that the coil is usually larger. (See energy conservation suggestions.) The water must be seasonally changed over from heating to cooling and back when the weather changes. Four-pipe units use separate heating and cooling coils. The heating elements will be hot water, steam, or electric. Cooling is via a separate chilled water coil. Each hot water or steam unit, then, has two supply pipes and two return pipes—thus, four pipes. Seasonal changeover is not necessary with four-pipe units.

FILTERS

Filters take dust and dirt out of the air before it enters the coil of the unit ventilator. Dirty filters greatly reduce air delivery and restrict the heating and cooling capacities of the unit.

Important: Units with direct expansion cooling coils must not be operated with dirty filters. Low air flow over a direct expansion coil can result in compressor failure.

A filter cleaning schedule should be based on experience for each room. A ground floor room near a playground area will require more changes or cleaning than will a similar room on an unused lawn area. Upper stories of a building generally do not require the frequency of service that is necessary for ground floor or basement rooms. A kindergarten room becomes loaded with lint more rapidly than any other room, due mainly to the rugs used by the small children. Filters become plugged more rapidly during the winter months than during the fall and spring seasons, because of lint from winter clothing. Therefore, individual room use, location, and season are the determining factors in the filter cleaning schedule.

Some unit ventilators use only one filter to clean all the air going through the unit. Other units have split filters, both in length and width. Large air handling units use a multitude of square filters. When the filter is long and very narrow, one filter is usually in a separate rack behind the other. If a filter is about six inches wide, there usually is another filter behind it. Do not miss cleaning or replacing this second filter.

There are three main types of filters available: the permanent (cleanable) type, the replaceable or throwaway type, and the renewable media filter.

A permanent filter has a metal frame with a crimped metal filter. To clean a permanent filter immerse it in a scalding cleaning solution and move it up and down rapidly to wash out the dirt and oil. A good cleaning solution can be made by dissolving one and one-half pounds of washing soda in 10 gallons of hot water. If a cleaning tank is used, there should be a false louvered bottom to prevent stirring up the settled dirt on the bottom of the tank. After the filters are cleaned, they should drain dry. They must be sprayed thoroughly or dipped with filter oil until the filter is coated all the way through. After oiling, the filter is racked over a drain pan for at least 12 hours to allow the excess oil to drain off. It is advisable to have extra filter cells of all required sizes so that some can be cleaned while the others are in service.

Replaceable or throwaway filters are made of spun glass interiors with a cardboard frame. After this type of filter has become dirty, it should be thrown away and replaced with a new filter. Cleaning the surface with a brush or broom does not clean this filter, nor will pounding it get out enough dirt. Some dirt, of course, will come out, but the oils on the glass media have already been soaked up and dirt will now pass through this "cleaned" filter. Enough throwaway filters of all required sizes should be stocked to make sure

clean ones are available.

Renewable media filters are a combination of the best features of permanent filters and replaceable filters. They have a metal suitcase-type frame and use spun glass for the filtering media. The renewable filtering media is purchased in a roll of the desired width compressed in a box. The spun glass filtering media is pulled from the box and cut off to proper length with an ordinary pair of scissors. The media is pre-oiled so no further oiling is necessary.

LUBRICATION

Oil sleeve bearings twice a year using an oil grade and weight recommended by the manufacturer. Grease ball bearings once a year through the zerk fitting or plug on the outside of each bearing. Over greasing will force the lubricant through the bearing, where it may be picked up by the fan and discharged into the room.

Belt tension should be adjusted if required. The belt should be just tight enough so that it does not slip, but not so tight that it causes excessive strain on motor or fan shaft bearings. If the belt becomes frayed or noisy, it should be replaced at once. Do not try to tighten a loose belt by closing the adjustable motor sheave. This will speed up the fan and cause noise.

INSPECTION

Some unit ventilators are furnished with a separate fusetron in the unit switch box, or it may be found in a separate box near the electric outlet box in the unit. The types and sizes of these fuses should be recorded and a small quantity of each size and type should be stocked.

If belt drive units are used, the belt sizes should be recorded and at least one of each size should be stocked. A belt that has remained in one position for some time may develop a hump and become noisy. For this reason, during extended shutdown periods, it is well to run all belt drive units once a month for a few minutes. This is especially important if the belt is very tight. Make sure that no oil from the motor or bearings gets on the belt. If it does, wipe it off immediately. Oil will ruin a belt.

If direct drive units are installed, couplings and bearings could be required. Since any given manufacturer standardizes on these items, all couplings and bearings in a classroom unit are identical on all size units of one manufacturer. Two of each usually should be stocked.

All unit ventilators use some type of special wrench, key or screw driver fastener to keep them tamperproof. It is recommended that two complete sets of these tools and fasteners be obtained, one set for the heat custodian and one set for the school's administrative office. If the custodian is not available, the office set will be available for emergency use. These special tools may be obtained directly from the unit manufacturer.

Do not, under any circumstances, try to oil the damper motors, valve stems or thermostats. If there is a malfunction in these parts, call the temperature control serviceman.

RECORDS

A complete set of records should be kept on each unit ventilator. If the building is comparatively new, obtain a set of "shop drawings" from the architect or heating contractor. These drawings give all pertinent information on each unit by room number. If shop drawings are not available, most manufacturers can furnish a file print for each unit—if the building is not too old. The only other alternative is to take a physical inventory and record the following:

Manufacturer _____	Room Number _____
Model Number _____	Date Installed _____
Serial Number _____	Belt Size _____
Motor Frame Number _____	Motor Shaft Sizes _____
Fan _____	Bearing Size _____
Fuses _____	Coupling Size _____
Outside Service Information _____	Motor full load amps _____

ORDERING PARTS

Always be prepared to give a complete model and serial number of the unit ventilator off of the nameplate when you call or write the manufacturer or your heating supplies distributor. In addition, when ordering motors, obtain both the unit and motor nameplate data. When ordering coils, be sure to specify whether coil is hot water or steam. Some buildings have been changed over from steam to hot water and the original unit model number alone may not give the proper coil selection. A typical unit model number will include a letter or series of letters followed by a series of numerals. This information will lessen the chance of part selection error and eliminate extra phone calls, thus speeding up part delivery. Requests for temperature control component

parts should be directed to the temperature control contractor, not the unit manufacturer (unless supplied by unit manufacturer).

ENERGY CONSERVATION

1) Clean units and regularly changed filters are essential for proper temperature control and result in less energy consumption.

2) When conditions permit, low speed fan operation saves energy except on direct expansion cooling operation. Low speed usually increases consumption during direct expansion cooling operation.

3) A seemingly tiny amount of dripping or poor trap operation on steam units can amount to dollars per year per unit. Repair or replace traps as required.

4) Improper burner operation on gas fired units can similarly add up in decreased fuel efficiency. Have a service contractor or local utility check all gas appliances immediately on the first hint of malfunction.

5) Check all temperature control devices for proper calibration periodically. Overheated rooms are the largest energy wasters. Overheating is possible on damper controlled units when hot water/outdoor air reset is not functioning properly or not used. Reset should be investigated for use on "moderate" days if you are experiencing overheating with all other components functioning properly.

6) In a building designed prior to 1974, some "minimum" outdoor air quantities can probably be adjusted downward and still be within applicable code requirements. Contact your consulting engineer or temperature control contractor.

7) Reduced thermostat settings (65 degrees in winter, 78 degrees in summer) save energy in unit ventilator systems during severe winter months and warm summer months. However, during "moderate" days, generally between 30 and 70 degrees outdoors in spring and fall months, these settings do not save energy. In certain cases, they may actually waste energy. Common sense is a good rule. When it's below freezing outside and cloudy, a 65 degree set point will save energy. The same goes for a 90 degree summer day and a 78 degree set point. However, when it's 60 degrees outside, a 65 degree setting will force a slightly less comfortable condition than would 72 degrees, and may even bring on cooling, depending on the internal heat gain in the room, which would cause additional unnecessary energy usage. A similar situation could be described for the higher set point. So the best suggestion for thermostat settings is reduce when possible, but use good common sense.

8) All direct expansion type cooling units should be wired to prohibit compressor operation via a low ambient lockout set at 55 to 60 degrees.

9) When coil freeze occurs, two things are usually wrong: below freezing air and no flow (of water or condensate) are present. Both should be addressed and corrected. Freeze-up cannot occur without both. Check for poor damper seals, damper motors and leaks around unit. Check also for obstructions to proper condensate flow.

10) Since most classrooms are occupied only about 15 percent of the 8,760 hours in each year, a night setback or "unoccupied" control sequence should be employed with unit ventilator systems. In this sequence, the room temperature is reduced by 5 to 18 degrees and the outdoor air damper is closed.

Unit Heaters

A unit heater consists of a fan and motor, a heating element, an enclosure or cabinet, and a directional outlet. There are three main types of unit heaters: (1) Horizontal Propeller Fan, (2) Vertical Propeller Fan, (3) Cabinet Type Centrifugal Fan. The cabinet type unit may be arranged to deliver air horizontally or vertically.

The heating medium can be steam, hot water, gas, or electricity. If they become inoperative, gas fired (natural gas) and electric unit heaters should be serviced by either a qualified service organization or by the local utility company.

Unit heaters all operate on the same general principle. Usually a room thermostat cycles the fan on when heat is needed. On steam or hot water units, a return line aquastat is wired in so that the motor will not run until the aquastat is satisfied. When the thermostat is satisfied, it

shuts the motor off. Some units are installed with a "summer-winter" switch mounted with the thermostat. When set in the summer position, the unit can be operated without the heating element being hot. This is used for air circulation when the heat is not required. The "summer" switch cuts out this controller.

With gas fired unit heaters, the room thermostat cycles the burner and the heat exchanger is allowed to get hot before the fan motor comes on. When the room thermostat is satisfied, it shuts off the gas valve while the motor continues to run until the heat exchanger cools off. Then the motor is stopped. The electric unit heater operates in a similar manner in that the coil is turned on before the fan motor starts, and again is turned off before the fan motor is stopped. The table below presents a suggested maintenance schedule for unit heaters.

GENERAL CLEANING

General cleaning is a most important factor in trouble-free and economical operation. The location of a unit is important to its cleaning schedule. A horizontal unit in a woodworking shop will require cleaning more often than will the same unit hanging in a clean storage room.

The heating element of a unit heater must be kept clean. The greatest amount of dirt, lint, sawdust, or other particles will be on the air entering side of the heating element. A good brushing will loosen most of the dirt. (Be sure to protect the motor from the dirt.) Do not remove a gas fired or electric heating element from a unit. Call a serviceman for this kind of work.

Inspect the fan for dirt. The fan can be cleaned by brushing; if very dirty, the fan can be washed but remove it from the motor shaft first. When

Maintenance and Inspection Schedules for Unit Heaters

Seasonal Heating Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.

2) Verify that thermostat operates properly.

3) Inspect safeties for proper mounting and operation.

4) Inspect fan wheels.

5) Inspect shaft and motor bearings.

6) Verify proper pulley alignment if applicable.

7) Inspect belts and replace as required and if applicable.

8) Lube all motors and bearings.

9) Brush clean supply air fan wheel as required.

10) Inspect filters and clean as required. (Replace filters if non-cleanable type.)

11) Check external interlocks for proper operation.

12) Inspect unit cabinet for proper integrity.

13) Measure voltage and amperage of motor.

14) Place system in operation and measure temperature rise through unit.

15) Provide a written report of work completed and indicate all detected deficiencies.

16) Gas Heat Routine:

- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold.
- Inspect flame condition.
- Verify integrity of the flue system.

17) Electric Heat Routine:

- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

18) Hot Water/Steam Routine:

- Inspect control valves and traps.
- Check and verify operation of operating and safety controls.
- Verify operation of heating coils.
- Brush clean coils as required.

Seasonal Heating Inspection

1) Check operation of the unit.

2) Verify operation of the fan.

3) Check condition of electrical wiring and operation of electrical components.

4) Check operation of the control circuit.

5) Perform routine maintenance as required including changing filters and lubrication.

6) Inspect belts for proper condition and alignment within pulleys if applicable.

7) Brush clean coils as required.

8) Verify proper operation of the heating section.

9) Check and verify operation of heating section safeties.

10) Verify heating energy source meets unit's requirements.

11) Provide a written report of work completed and indicate all detected deficiencies.

replacing a fan on the motor shaft, or just inspecting it, pay particular attention to tightening the set screws. These screws should seat on the flat or key-way of the motor shaft.

After oiling the motor, wipe up all excess oil. This will help keep both the motor and the fan clean. Oil left on the motor rapidly collects an insulating coat of dirt, which causes the motor to heat up and shorten its life.

During general inspection, check the unit casing. Tighten loose nuts and bolts. Make sure electrical connections are tight and not rattling against the unit casing. If the casing shows signs of rust, scrape the spots clean and retouch with paint.

The exterior surfaces of the unit should be cleaned the same as polished furniture.

FILTERS

Most cabinet units have a filter rack built into the cabinet. Filters are installed to take the dust, lint, and dirt out of the air before it enters the coil. A dirty filter, just like a dirty coil, greatly reduces the air delivery of a unit heater and, therefore, reduces the heating ability of the unit. Dirty filters and/or coils are the major cause of service calls complaining of "no heat."

LUBRICATION

Sleeve bearing motors are wool packed, oil lubricated bearings. A few drops of oil about three times a year will keep these motors in fine running shape. Be sure to use the grade of oil recommended by the manufacturer and **do not over oil.** Wipe up all spillage. The cabinet type unit heater also uses sleeve bearings on the fan shaft. These bearings should be oiled at the same time with the same type oil. When oiling these units, be careful not to get any oil on the belt drive. If this should happen, wipe it up immediately.

Ball bearing motors should be greased about twice a year. Note that the plugs should be removed from the bottom of each bearing before supplying grease through a zerk fitting or grease plug. If the bottom plug is not removed, grease will be forced through the bearing into the motor winding. Remove surplus grease and replace grease plugs. Grease used on vertical unit heaters should be of the high temperature type recommended by the motor manufacturer.

Fan and Furnace Inspections

ROOF-MOUNTED EXHAUST FANS

Annual Inspection

1) Check electrical wiring and electrical components for proper operation.

2) Check operation of the control circuit and the system interlocks.

3) Inspect fan wheel.

4) Inspect shaft and motor bearings.

5) Verify proper pulley alignment.

6) Inspect belts and replace as required.

7) Verify proper fan belt tension.

8) Lube all motors and bearings.

9) Brush clean fan wheel or blades. (Grease handling fans will require a more thorough cleaning.)

10) Measure motor voltage and amperage.

11) Measure fan wheel RPM.

12) Lubricate associated dampers and linkages.

13) Verify integrity of housing and connections.

14) Inspect starter/contactor and associated wiring, including electrical connections for tightness.

15) Inspect filters and clean as required. (Replace filters if non-cleanable type.)

16) Inspect for proper sealing of exhaust fan base to the exhaust ductwork and curb.

17) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Inspection

1) Check operation of the unit.

2) Check electrical wiring and electrical components for proper operation.

3) Check operation of the control circuit and the system interlocks.

4) Perform routine maintenance as required, including changing filters and performing necessary lubrication. Also clean grease filters and grease troughs.

5) Inspect belts for proper condition and alignment within pulleys.

6) Provide a written report of work and indicate detected deficiencies.

SYSTEM PRIMARY FANS

Annual Maintenance Inspection

1) Check electrical wiring and electrical components for proper operation.
2) Check operation of the control circuit.
3) Inspect fan wheel.
4) Inspect shaft and motor bearings.
5) Verify proper pulley alignment.
6) Inspect belts and replace as required.
7) Verify proper fan belt tension.
8) Lube all motors and bearings.
9) Brush clean fan wheel or blades.
10) Measure motor voltage and amperage.
11) Measure fan wheel RPM.
12) Lubricate associated dampers and linkages.
13) Verify integrity of housing and connections.
14) Inspect starter and associated wiring including electrical connections for tightness.
15) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Inspection

1) Check operation of the unit.
2) Check electrical wiring and electrical components for proper operation.
3) Check operation of the control circuit.
4) Perform routine maintenance as required including changing filters and performing necessary lubrication.
5) Inspect belts for proper condition and alignment within pulleys.
6) Provide a written report of work completed and indicate all detected deficiencies.

FURNACES

Seasonal Heating Start-Up

1) Check electrical wiring and electrical components for proper operation and condition.
2) Verify that thermostat operates properly.
3) Inspect safeties for proper mounting and operation.
4) Inspect fan wheels or blades.
5) Inspect shaft and motor bearings.
6) Verify proper pulley alignment if applicable.
7) Inspect belts and replace as required and if applicable.
8) Lube all motors and bearings.
9) Brush clean supply air fan wheel as required. Inspect filters and clean as required. (Replace filters if non-cleanable type.)
10) Check external interlocks for proper operation.
11) Inspect unit cabinet for proper integrity.
12) Measure voltage and amperage of motor.
13) Place system in operation and measure temperature rise through unit.
14) Provide a written report of work completed and indicate all detected deficiencies.
15) Gas Heat Routine:
- Check operation of gas train components.
- Check burner sequence of operation.
- Check combustion blower assembly and clean if required.
- Check combustion efficiency (if possible).
- Inspect heat exchanger.
- Check gas pressure to unit and/or at manifold.
- Inspect flame condition.
- Verify integrity of the flue system.

16) Electric Heat Routine:
- Inspect electrical connections and contactors.
- Check and verify operation of operating and safety controls.
- Verify operation of heating elements.
- Measure voltage and amp draw of heating elements.

Seasonal Heating Inspection

1) Check operation of the unit.
2) Verify operation of the fan.
3) Check condition of electrical wiring and operation of electrical components.
4) Check operation of the control circuit.
5) Perform routine maintenance as required including changing filters and lubrication.
6) Inspect belts for proper condition and alignment within pulleys if applicable.
7) Brush clean coils as required.
8) Verify proper operation of the heating section.
9) Check and verify operation of heating section safeties.
10) Verify heating energy source meets unit's requirements.
11) Provide a written report of work completed and indicate all detected deficiencies.

Pumps

Pumps installed in schools are confined mostly to a small range of types, thus simplifying maintenance.

Pumps circulate or move water, either in a "closed" system where the water is used over and over again (as in heating or cooling), or in an "open" system where water is consumed or replaced (as in a sump pump or domestic hot water pump). All of these pumps fall into general classifications.

Types of Pumps

The two classifications of pumps most likely to be found in a school building are (1) centrifugal pumps and (2) turbine pumps.

Centrifugal pumps are found in several configurations:

1) In-line circulators, which are mounted directly in the pipe line.

2) Base-mounted, flexibly-coupled pumps, which have pump and motor mounted on a common base and connected through a coupling. These pumps may be vertical or horizontal split case, may be single or double suction, and may have suction and discharge openings located in the end, side, or top.

3) Base-mounted, close-coupled pumps, which have the impeller located on the end of an extended motor shaft.

Turbine pumps have different hydraulic characteristics. If this type of pump is found in a school, it will usually be in boiler feed service. Unlike centrifugal pumps, turbine pumps can require impeller adjustments which should be performed by an experienced mechanic according to the manufacturer's recommendations.

Common Pump Components

All pumps in these categories have some characteristics and terminology in common:

Stuffing box, in which a variety of mechanical seals or packing may be installed to seal the pumped fluid from the atmosphere at the shaft opening.

Mechanical seals do not leak when operating properly, while *packing* requires a certain amount of leakage for lubrication. For this reason, a packed stuffing box is not generally used in a closed water system unless the fluid temperature exceeds the limits of mechanical seals.

Oil lubricated or grease lubricated pumps. The difference between these can be observed generally by the type of fitting provided for lubrication or from the manufacturer's directions.

Flexible couplers, which allow limited movement between pump shaft and motor shaft, or solid couplers in which the pump shaft and motor shaft are rigidly connected.

All *iron*, *bronze fitted*, or all bronze pumps, selection of which generally depends upon pump usage. Heating pumps usually are bronze fitted. Plumbing pumps usually are all bronze.

Service Recommendations

Pumps should be inspected weekly and maintenance performed as follows:

1) Motors and pumps must be oiled or greased in accordance with the manufacturer's directions. Do not over oil motors and be sure to use the proper lubricant. Pumps with oil cups must be visually inspected to assure proper oil level. Grease lubricated pumps must be inspected every 90 days and lubricated if necessary. It is far better to lubricate with small quantities at regular intervals than to over lubricate.

2) Couplers should be checked at regular intervals, particularly the solid disc types. Worn disc couplers or malfunctioning spring couplers can be a primary cause of bearing failure.

3) Rubber mounted motors should have mounts checked annually for deterioration and all bases checked for loose mountings.

4) Mechanical seals require no maintenance. If seals leak, they should be replaced or they will continue to leak at an increasing rate.

5) "Stuffing boxes" should be checked regularly and should be repacked by an experienced pump specialist when leakage becomes excessive.

6) After extended shutdown, pump and motor shafts should be turned manually to see that they turn freely and that any deposited sediment is churned before the motor is started.

7) When reinstalling a motor, the shafts must be carefully checked for alignment.

8) Any pumps that are drained and left idle require careful lubrication and the interiors and impellers must be rustproofed.

9) Strainers on the pump suction must be checked at regular intervals and cleaned. The

intervals will depend on the amount of water makeup, type and age of piping, etc.

Trouble Shooting

Following is a listing of the most common pumping troubles found in closed hot water heating systems and their probable causes.

Vibration noise can be caused by any of the following:

- Misalignment of motor and pump shafts; they should be within .005 inches both vertically and horizontally.
- Loose pump and motor base mountings.
- Pump base is inadequately "grouted." This means to fill under the base with cement made with a mixture of three parts sand to one part cement.
- Pipe strain on either suction or discharge connections.
- Check pump coupler.
- Broken or worn springs or arms on flexible coupler.
- Worn discs in solid-type coupler.
- Worn motor bearings.
- Worn pump bearings.

A common misconception is that flexible pipe connectors eliminate vibration. They are primarily for pipe misalignment.

Cavitation noise (sounds like pumping gravel) can be caused by:

- Air in the system. Each system should have some device (air separator, dip tube, etc.) for separating air at the boiler or converter. Verify that automatic air vents are operating; check all manual air vents.
- An inadequate supply of water to the impeller. Check for adequate water level in the system.
- Inadequate system pressure. Check gage on pump suction, both with pump running and with pump off. The pressure must be adequate to supply water to the highest point under all conditions. (Gage reading "Vacuum" indicates a condition that can damage pump.)
- Inadequate length of horizontal piping on suction side of pump.
- Misplacement of expansion tank; it should be on suction side of pump.
- Inadequate size of suction piping; it must be full size of pump inlet.
- Motor amperage not within motor rating. If above normal, close the pump discharge valve until amperage drops to normal. (Does not apply to peripheral turbines.) If normal amperage cannot be achieved, check with consulting engineer.
- Fouled strainer; always check to insure that it is clear.

Squealing noise may be caused by a lack of lubrication on either pump or motor. It may mean bearing or seal trouble. If squealing comes from the stuffing box, there may be too tight an adjustment on the "gland."

Mechanical Failures—Motors

If a motor does not reach running speed, check for a defect in the running winding or in the starting switch.

If a motor will not start:

- Check overload heaters and contacts if a starter is used.
- If fused, check fuses.
- Disconnect the coupler from the pump shaft. Motor should turn easily by hand. If too tight, then the bearings are bad. If there is too much endplay, then the bearings are worn.
- Turn on motor and see if it operates with no load.

Mechanical Failures—Pumps

"Frozen" shaft on a pump may be caused by lack of bearing lubrication, by a foreign object caught in the impeller, or by corrosion around the seal or impeller.

For any of these difficulties, pumps of the vertical or horizontal "split case" design may have removable bearing brackets and may be serviced without disconnecting the piping or misaligning the motor. Other styles must be serviced by removing the suction piping before working on seal or impeller.

Safety

Pumps should be treated like any other piece of rotating machinery. All exposed rotating parts should have a guard. When performing maintenance other than lubrication, the local controls as well as the main power disconnect should be turned off and tagged.

Energy

In the original design, efficiency was a consideration in pump selection and system design. However, there may be cases where a pump must

be "throttled" to achieve proper system balance. If this occurs, it might be advantageous to trim the impeller to meet this condition without throttling. This can result in a lower amperage draw. The design engineer can advise whether this possibility exists.

Annual Inspection

1) Check pump alignment with the motor.
2) Inspect the coupling for proper connection and wear.
3) Lubricate pump bearings as required.
4) Lubricate or oil motor bearings as required.
5) Inspect the mechanical seals for wear and leaks.
6) Verify that pump assembly produces the pressure as required for the system.
7) Inspect electrical wiring and components for proper operation.
8) Check operation of the control circuit.
9) Verify that motor safeties and overloads are adjusted to the proper settings.
10) Measure voltage and amp draw of pump motor.
11) Check motor mounts and vibration pads and adjust as required.
12) Check and clean strainers.
13) Provide a written report of work completed and indicate all detected deficiencies.

Seasonal Inspection

1) Check operation of the pump.
2) Inspect electrical wiring and components for proper operation.
3) Inspect for signs of leaks or unusual wear.
4) Verify that pump assembly produces the pressure as required for the system.
5) Perform routine maintenance as required.
6) Provide a written report of work completed and indicate all detected deficiencies.

Steam Traps

For steam traps in normal service, a typical preventive maintenance schedule is shown in the table on page 177. However, if the traps are subjected to severe service (water hammer present, excessive condensate loads, large amounts of dirt or scale), more frequent inspections and replacement of parts may be required.

Steam traps can fail in two ways—fail to open and fail to close. When a trap fails to open, condensate accumulates in the drip leg and eventually floods the heat exchange equipment. Conversely, a trap that fails to close wastes live steam. The cause of a trap to fail—open or close—varies for different types. However, there are certain things that happen when any trap fails.

Safety

When working with steam traps, remember that they are pressure vessels and contain hot fluids under pressure. Never attempt to open a trap body without first turning off the valves in the inlet and discharge lines and allowing the unit to cool.

When testing traps where condensate return lines are overhead, guard against the backflow from other traps or from the return lines. Aside from being a safety hazard, this backflow can produce false indications during trap testing.

When operating the steam trap with a test cock or union connection open, keep away from the hot condensate. Also, do not attempt to direct the trap discharge into a shallow pan, as velocities may be sufficient to scatter the hot liquid and cause severe burns.

CHECKING TRAP OPERATION

There are several methods of checking steam trap operation. (See *Figure 20-1.*) One of the easi-

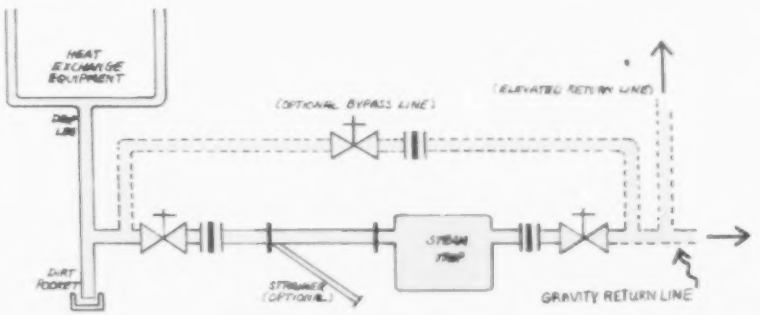

Figure 20-1—A typical steam trap installation.

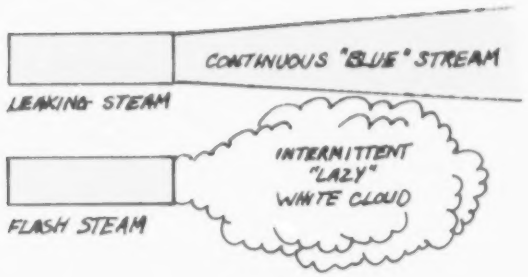

Figure 20-2—Don't confuse flash steam with leaking steam. To tell the difference, open the outlet line. If steam blows out in a continuous "blue" stream, it is leaking steam. If steam floats out intermittently (each time the trap discharges) in a white cloud, it is flash steam.

est methods is to measure the temperature of the piping on each side of the trap. The inlet piping should be hot, and the discharge piping much cooler. Use any good temperature measuring device, such as a pyrometer, to make the readings. If such a device is not available, put on a good pair of heavy work gloves and grasp both pipes. A temperature difference between the trap inlet and discharge lines should be felt. If both pipes are cold the condensate is not being removed from the heat exchange equipment. The trap may not be opening, or the line may be blocked. If both inlet and discharge lines are equally hot, indications are that the steam trap is not closing properly.

Check other traps on the same discharge line. Often the failure of one trap produces pressure in the discharge line, resulting in high temperatures downstream of other traps that use the same return main. For this reason, temperature testing is not a good method of determining if a trap is leaking steam. A better determination can be made by using an ultrasonic test instrument. These instruments are rather expensive and require a certain amount of skill to relate test results to the type of trap being tested.

A practical system of determining steam loss through traps is to install a sensor chamber in front of the trap. To test for steam loss, a portable indicator is connected to the chamber. The indicator measures the difference in conductivity between condensate and leaking steam and shows directly by means of a "pass" or "fail" light when a trap is losing steam.

Another method of checking steam trap operation is to observe the steam trap discharge. In some installations, a test cock is provided in the trap discharge line. In other installations, it is necessary to open a union connection downstream of the trap to observe the discharge.

Warning: The discharge from steam traps is hot condensate (scalding water) under pressure. When released to atmosphere, the condensate produces considerable "flash steam." Don't get burned. Close valves and allow trap and piping to cool before opening any union. Be sure that a valve downstream of the trap is closed to avoid backflow from the return main.

When the steam trap is operating with an open discharge line, notice the type of discharge and the volume of condensate compared to that of steam. Inverted bucket, thermostatic, and disc (impulse) traps have intermittent discharges, accompanied by clouds of flash steam. (See *Figure 20-2.*) If a disc trap discharges more often than 10 times a minute, it is a sign of wear and should be replaced or repaired. Float and thermostatic traps discharge condensate continuously as it enters the trap body. Because of the continuous drainage, it is more difficult to distinguish between live steam and flash steam.

When a steam trap appears to be faulty, check the other elements in the pipe lines to be sure that the fault is in the trap. Valves in the trap inlet and discharge lines should be fully open. If there is a bypass around the trap, its valve must be closed tightly. If there is a strainer ahead of the trap, be sure that the screen is not clogged by dirt and scale.

Also check the condensate line downstream of the trap to be sure that it is not fully or partially blocked. If the condensate is discharged to an overhead return line, be sure that the pressure at the trap inlet is sufficient to do the lifting. For systems above 15 psig, pressure must be about 1 psi for every 2 feet of lift. For systems below 15 psig, condensates should drain by gravity to the condensate receiver or pump. If absolutely necessary to lift condensate, the lift should not exceed three feet.

STEAM TRAP REPAIR

When the trouble has been traced to a particular steam trap, close the inlet and discharge valves and allow the trap to cool. To minimize downtime, remove the faulty trap or trap mechanism and immediately replace it. The faulty trap or mechanism can then be repaired and stored until needed.

Inverted Bucket Traps

To repair an inverted bucket trap (see *Figure 20-3*), open the trap and discard the old gasket. Scrape gasket surfaces clean. Remove excessive scale and dirt from the inside of the trap body. Place the cap in a vise and remove the bucket from the lever. Clean the bucket, making sure that the vent hole at the top of the bucket is open. Inspect the valve lever and valve guides for wear. Inspect the valve and seat. There should be a narrow, bright ring around the valve and a sharp edge on the valve seat. If any of these parts are worn, it is good preventive maintenance to replace all parts. When replacing the valve and valve seat, be sure that both new parts are of the correct orifice size for operating steam pressure.

Some inverted bucket traps have thermal elements also. One type has a bi-metallic strip that closes a secondary vent in the bucket. Inspect the thermal element for wear, misalignment, or other damage. When placed in a pail of boiling water, the vent should close. If the thermal element in the bucket is faulty, replace the bucket. Another has a diaphragm or bellows in the cap. If it has failed, replace the element. (Do not check this type in boiling water.)

After installing the necessary parts in the trap mechanism, align the assembly so that the lever moves freely and the valve seats tightly on the orifice. When the mechanism is aligned so that it operates freely, attach the bucket to the end of the lever. Using a new gasket, reassemble the trap and tighten bolts securely, opposite ones first.

On some occasions, an inverted bucket steam trap won't close because it has "lost its prime." It can be reprimed by closing the valve in the trap inlet until the condensate accumulates in the drip leg; then slowly open the valve and let the water enter the trap. If the trap does not then function properly, something else is probably the cause.

Float and Thermostatic Traps

Generally, float and thermostatic traps (*Figure 20-3*) can be repaired without breaking the pipe connections. Remove the cap bolting and separate the cap, mechanism attached, from the trap body. Discard the old gasket and clean gasket surfaces. Clean dirt and scale from the bottom of the trap body.

Inspect all of the working parts for indications of wear or damage. The valve and seat may be worn or wire drawn (steam cut). Lever and pivot pin may be worn, preventing proper alignment of the valve and seat. The float may be collapsed or may have a pinhole leak. The thermostatic element may become misaligned, worn, or damaged. Check the castings for places worn thin by erosion. Replace any faulty parts with new ones. When the valve and seat are replaced, be sure to install the proper orifice size for the operating pressures. Be certain the lever moves freely and the valve seats tightly on the orifice.

Reassemble the trap, using a new gasket between the cap and body. Tighten bolts securely and restore the trap to service.

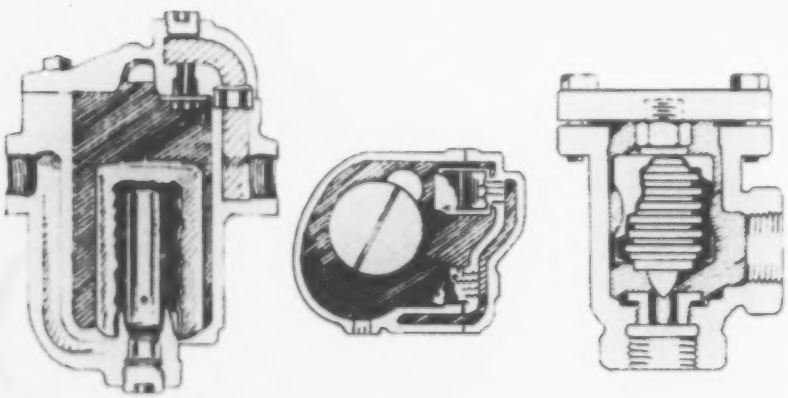

Figure 20-3—Inverted bucket trap (left); float and thermostatic trap (center); thermostatic trap (right).

Thermostatic Traps

To inspect the thermostatic trap (*Figure 20-3*), open the trap body and inspect the thermostatic element. Bellows and diaphragm type units may rupture, collapse, or develop leaks. Bi-metallic units may break or corrode. As in all steam traps, the valve and seat may wear so that they do not close properly. When the trap is cold, the valve should be open.

Replace all worn or damaged parts, and reassemble the trap, using a new gasket.

Disc and Impulse Traps

Disc traps (*Figure 20-4*) are easily maintained because they have only one moving part and you can hear them "click" as they discharge condensate. Blowing problems are generally caused by dirt or scale caught between the seat and disc, which is easily removed when the cap is opened. The disc must be clean and feel smooth when rubbed against the seat.

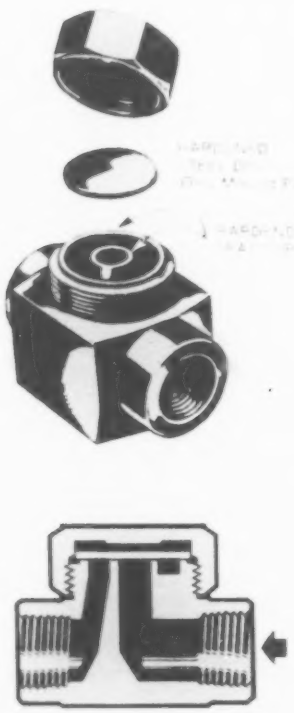

Figure 20-4—A disc trap shown in an exploded view (above) and cross-section view.

Typical Preventive Maintenance Schedule for Steam Traps

Check trap operation	2 months
Clean strainer ahead of trap	4 months
Open trap and clean; replace worn parts	12 months*

*Experience will dictate frequency of trap cleaning and parts replacement.

Some types require the replacement of a preassembled cartridge. To repair them open the trap and remove the faulty trap element. Clean away the dirt and scale, making sure that metal-to-metal surfaces are clean and smooth. *Do not use gasket or pipe joint compound* on metal-to-metal sealing surfaces. If the body is wire-drawn where the cartridge seats off, it will not seal and the entire trap must be replaced. If the body is in good condition, install a new element and reassemble the trap.

Non-Repairable Traps

Some of the newer traps are made of stainless steel and are permanently sealed. If such a trap malfunctions, the problem may be dirt or scale lodged in the trap mechanism. Remove the trap from the line and back-flush the trap with water or compressed air. If there is a check valve in the trap inlet, be sure that it is blocked open during backflushing. If the malfunction persists, replace the trap with a new one.

Energy Conservation

Because steam traps are relatively small, and are often located in out-of-the-way places, their importance is often underestimated. Steam traps are among the factors that determine the efficiency of heat exchange equipment. When steam traps fail to open, unit heaters and radiators become cold and will not heat. Also, steam mains may be improperly drained resulting in reduced steam flow through the main, wet steam, and water hammer. With condensate and air in a steam system, more steam is required to do the work. Excessive loads in some branches can upset the balance of a steam system.

When a steam trap fails to close, that one steam trap can waste more than 200,000 pounds of steam per month (figure based on a 3/8 inch

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orifice at low pressure). In terms of fuel, that amounts to some 1,900 gallons of fuel or its equivalent.

Annual Inspection

Steam traps should be included in the annual inspection of the heating and ventilating system. See the Annual Inspection Checklist in the Management Tools Appendix.

Additional Information

If additional information on the trap sizing is needed—orifice sizes for different pressure, maintenance instructions, parts identification, or application assistance—contact the manufacturer of the traps being used. The manufacturer is identified on the casting or on a tag affixed to the trap.

Valves

Valves control the flow of fluids. They start, stop, direct, regulate, or throttle the volume and rate of flow of water, steam, and gases. There is no universal type of valve to accomplish all these purposes, but there are six basic designs of manually operated valves usually found in schools. Each basic design has numerous modifications to meet special needs. *Figures 20-5* through *20-11* illustrate the various valves and modifications found in schools. It is essential that the maintenance serviceman understand the mechanics of the particular valve under inspection or repair.

In addition to manually operated valves, most schools will have some type of automatically controlled valves for the temperature control system.

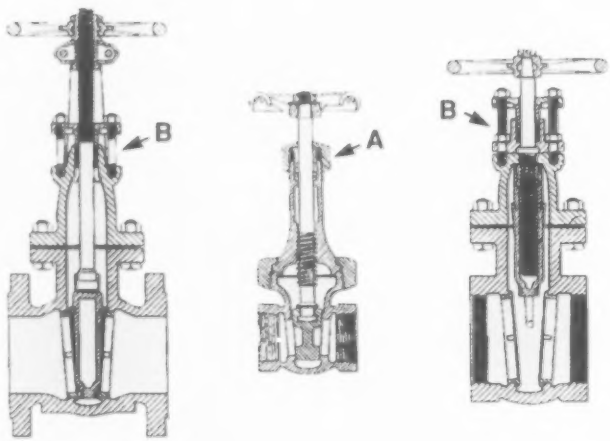
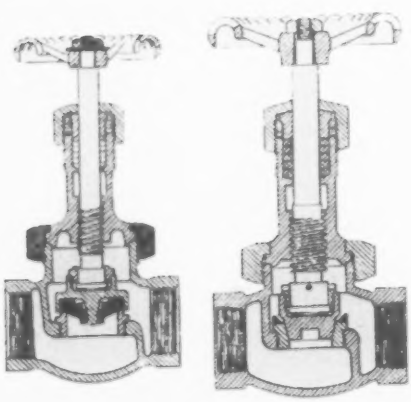


Figure 20-5—Gate valves. Outside Screw and Yolk (OS & Y) stem design (left); inside screw, rising stem design (center); inside screw, non-rising stem design (right).

MANUALLY OPERATED VALVES

1) Gate valves (*Figure 20-5*) provide tight shutoff. They offer little obstruction to the flow of fluids, have little turbulence through the valve, and therefore, have very low pressure drop. They



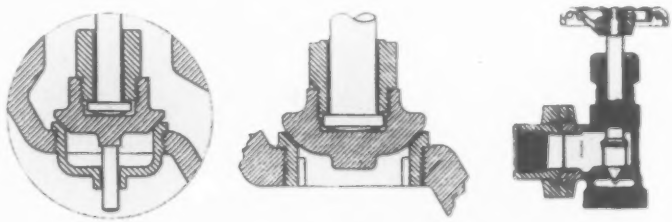


Figure 20-6—Globe valves. Bronze disc globe valve (far left) has disc that is easily replaced. Plug disc design (second from left) is one of several popular designs. Narrow conical seat globe valves come in two designs. In one (above, left) the disc seating surface has the same angle as the body seat; in the other (center, above) the disc seating surface is curved. Another design is the needle valve (far right, above).

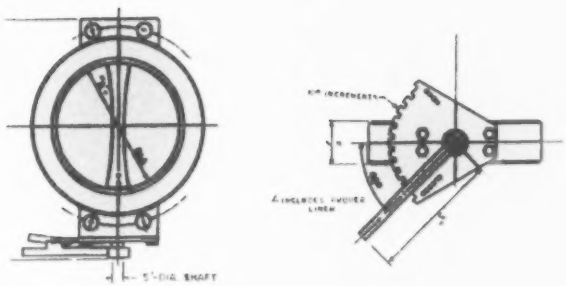


Figure 20-7—Butterfly valve.

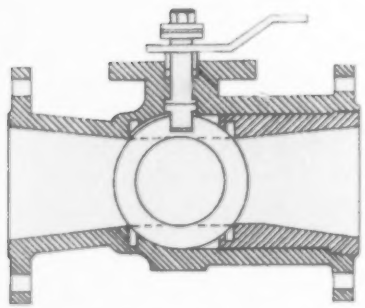


Figure 20-8—Ball valve. The outer circle in the center of the valve is the ball and the inner circle is the hole opening. Valve is shown in closed position. Dashed lines show ball rotated 90 degrees to open position.

are used only in the wide open or fully closed position.

2) Globe valves regulate or throttle the rate of flow (such as in a bypass around a pump regulator) or balance flow in several branch lines off a main line. Volume of flow is proportional to the turns of the handwheel.

A globe valve operates efficiently in any position, because it has a seating surface which minimizes seat erosion from the high velocity of fluid movement. (This erosion is called "wire drawing.") *Figure 20-6* shows various types of globe valves.

3) Butterfly valves are used where both shutoff and throttling are needed with viscous fluids. They are not used on steam or gases. Since

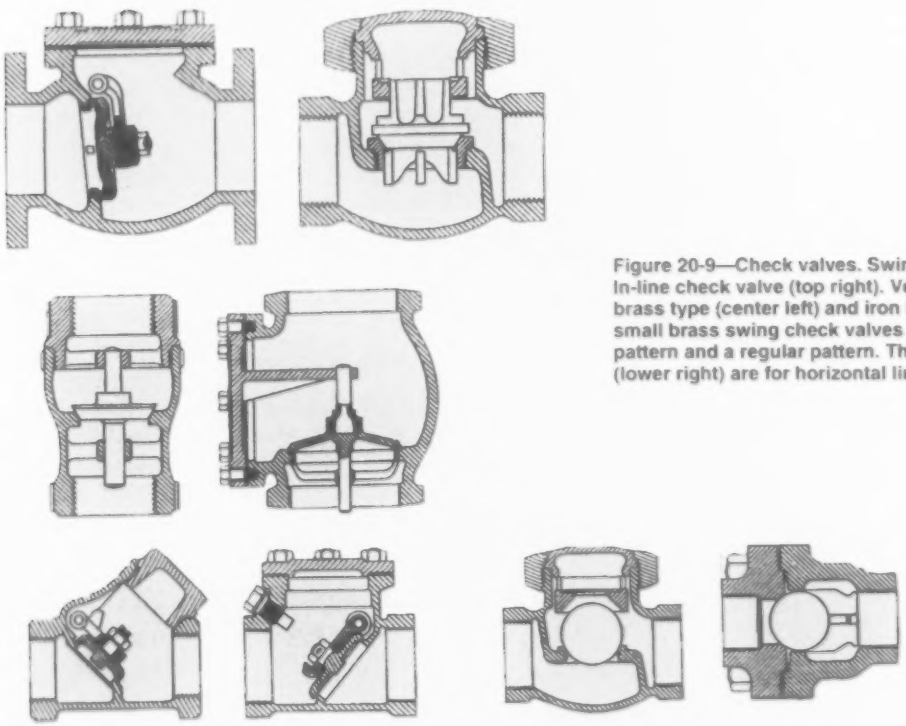


Figure 20-9—Check valves. Swing check valve (top left). In-line check valve (top right). Vertical check valves include brass type (center left) and iron body (center right). The two small brass swing check valves (lower left) include a "Y" pattern and a regular pattern. The two ball check valves (lower right) are for horizontal lines only.

butterfly valves fit between companion flanges, they cannot be removed for repair without upstream shut-off unless double lug valves are provided. *Figure 20-7* shows a typical butterfly valve.

4) Ball valves (*Figure 20-8*) are a more modern type used to perform the same function as globe valves. This valve has a rotating ball with a hole through it that allows straight-through flow in the open position and shuts off flow when the ball is rotated 90 degrees to block passage. It requires only a quarter turn from open to closed while the globe valve requires multiple turns.

5) Check valves are used to prevent the reversal of flow in a line. The pressure of the flowing fluid keeps the valve open. The differential pressure on flow reversal closes the valve automatically, and tightness of seat depends upon how high the back pressure is. *Figure 20-9* shows various types of check valves.

A special check valve often found in schools is the boiler stop check valve, which is located in the steam outlet on top of the boiler. The valve shown in *Figure 20-10* is a globe pattern, but the stop-check valve also is common in an angle pattern. It is a combination of a lift-check and globe valve. As shown in *Figure 20-10* the stem is not attached to the disc, and is used only to close the valve when required for boiler testing or shutdown.

6) Cocks and plug valves were probably the first valves known to man. Because of their simplicity and low cost, they find widespread use in shutting off water, oil, air, and gas. *Figure 20-11* shows two common types.

AUTOMATICALLY OPERATED VALVES

Automatically controlled valves found in the temperature control system are special modifications of (but similar to) globe, ball or butterfly valves with automatic actuators. The actuators have one of five motive forces:

1) Pneumatic or air operated actuators are either diaphragm, bellows or piston operated, usually with air at a maximum of 15 pounds per square inch.

2) Electric motor operated actuators are either cam operated uni-directional or reversing motors with a gear train. A release mechanism and spring return must be used if the valve is to be returned to a preselected open or closed position on power failure.

3) Self-actuated control valves have a remote, temperature-sensitive bulb or element connected

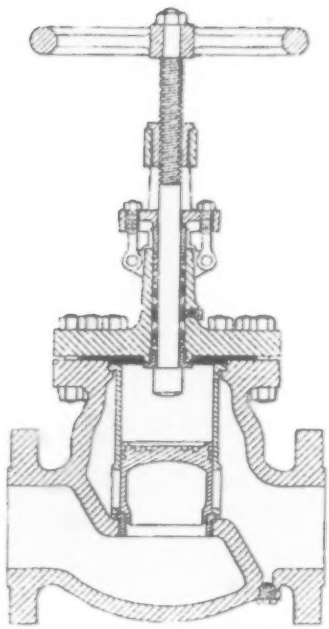


Figure 20-10—Stop-check valve is found in several patterns on school boilers.

by a capillary or hollow metal tube to a diaphragm or piston operator. The element and capillary are sealed and filled with a fluid or vapor which expands when heated, creating a pressure which operates the actuator to open or close the valve.

4) Solenoid operated valves have a coil of wire surrounding the valve stem. When electric power is applied to the coil a magnetic field is created which raises the valve stem similar to a magnet pulling a nail to it. The magnetic power generated is limited by the size of the coil, so this type of valve is used only for open-closed operation in smaller sizes normally under 1-1/2 inch pipe size.

VALVE MAINTENANCE AND CARE

With minimum maintenance effort, thousands of dollars in valve replacement can be saved each year. Most manual valves need to operate only in emergencies. A little care will ensure proper operation when desperately needed.

Leaking is the major problem encountered with valves. A valve can leak internally by not shutting off completely when required. More commonly, valves leak externally at various connections, such as where the pipe joins the valve or

flange, around the stuffing box, or where the body and bonnet connect. Frequent and regular inspection, therefore, is the best valve maintenance. When a leak is found, it should be corrected immediately, as time will only make it worse, not better.

In most cases, external leaking can be corrected by tightening the flange bolts or stuffing box nut. (See hexnut at **A** and flange bolts at **B** in *Figure 20-5*.) Be sure to use the proper type and size wrenches to fit the job. Excessive torque at the wrong point can result in problems greater than the original leak. When tightening the packing gland nuts, the valve stem should be moved up and down a little first to free the stem from the packing material. Next, tighten down the stuffing box with enough pressure to make stem movement difficult. Then loosen the packing nut so it is free and tighten it down again only finger tight. Finally, move the stem up and down again and tighten further only as required to stop leaking.

Caution: When opening a closed valve, do it slowly. Surge pressure or rapid temperature change can easily damage piping or equipment downstream of the valve.

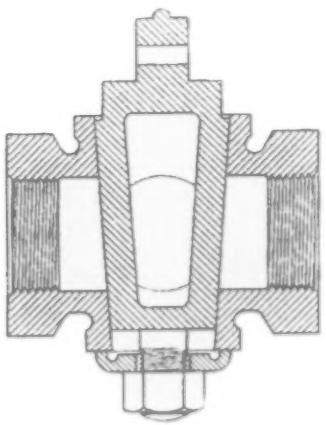
If proper tightening fails to correct the leak, the only solution is to replace the flange gaskets or the stem packing.

Replacing Gaskets

The use of proper gaskets is the answer to maintaining tight flange joints. The gaskets must properly match the flanges and must be suitable for the fluid carried in the line. There are numerous types of flange faces used for as many different applications. The gasket must match the type of flange face. (See *Figure 20-12* for various types of flange faces and gaskets. Some of these are common in schools; some are not.)

Probably the most common type used in schools is the plain (flat) face flange used on brass, bronze, and 125-pound cast iron valves. The gaskets for these flanges should always be full faced and non-metal, because any gasket with an outside diameter less than that of the flange may produce excessive bolting load on the flange metal. With a narrow gasket, the flange has an open space beyond the outside edge of the gasket. This causes the flange to assume the functions of a cantilever (*Figure 20-13*). Non-metal gaskets are preferred for these conditions, because they require less unit loading to make a tight joint than do metal gaskets.

When opening or tightening the bolts on a flanged joint, the nuts directly across from each other should be loosened or tightened in sequence similar to the method used to tighten the lug nuts



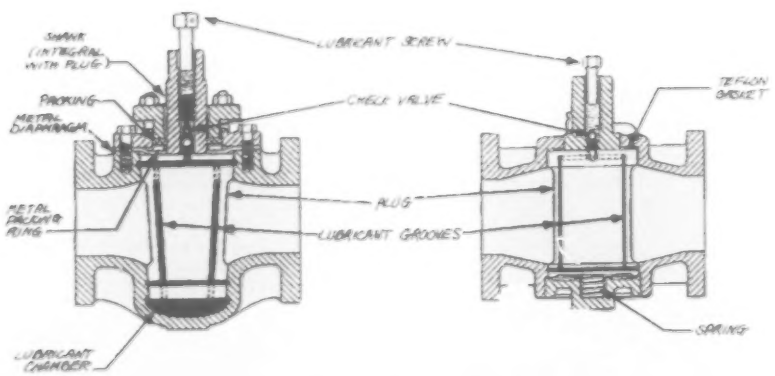


Figure 20-11—Plug cock valve (left) is of simple straight-way design and shown in a closed position. Two typical designs for lubricated plug valves (below) include one with conical shaped plug (lower left) and one with a cylindrical plug.

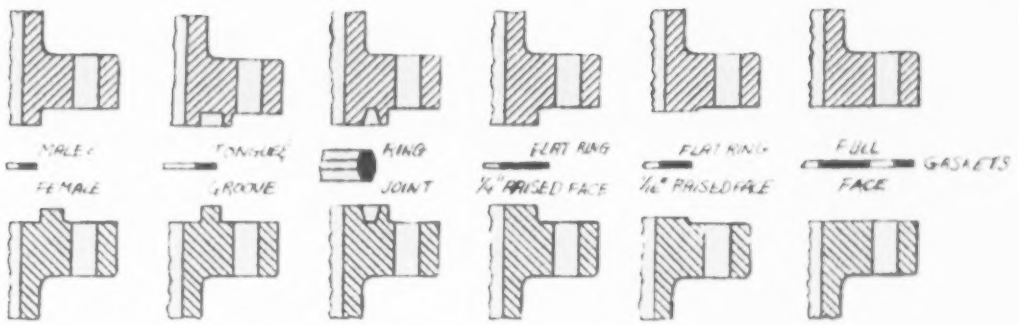


Figure 20-12—Flange facings come in several standard types with corresponding gaskets.

on an automobile wheel.

Before installing new gaskets be certain that the flange faces are thoroughly cleaned and polished and that the gasket is properly aligned on the flange face.

Questions about flanges or gaskets should be referred to the supply house or contractor.

Repacking Stuffing Boxes

A leaky stuffing box may be caused by a loose nut, worn out packing, or a corroded stem.

Most valves are designed with a back-seating arrangement that temporarily holds back the fluid while repacking. After the old packing is removed, check the valve stem to be sure it is smooth and polished. If it is pitted, probably no amount of stuffing box tightening will stop the leak. Thus, it is necessary to shut down and repair the valve.

The stuffing box must be cleaned before installing the new packing. The packing should be of material recommended for the service. The most common types are graphite string or ribbon or nylon or teflon in either ribbon or formed pieces. After the new packing is in place, tighten down the stuffing box nut and follow the procedure mentioned earlier for tightening nuts in the proper sequence.

Both manually operated and automatically actuated valves have similar packing arrangements, but the packing is much more critical in an automatic valve to insure proper operation. Unless maintenance personnel are familiar with the automatic valve, any service may be best left to the manufacturer's service department.

Replacing Worn Discs

When the valve does not shut off completely, the disc should be checked and replaced if worn. To check the disc, turn the stem to the closed position, open the bonnet joint where the stuffing box and stem assembly join the valve body, and lift out the entire assembly. Check the valve seat in the body for smoothness.

To replace the disc, remove the retaining nut and install the new disc. The disc must be of proper composition for the type and temperature of fluid. Note also that the stem is attached to the disc holder by means of a slight swivel. This action is required to allow the disc to properly seat.

It is recommended that only trained personnel replace discs or seats in automatic control valves.

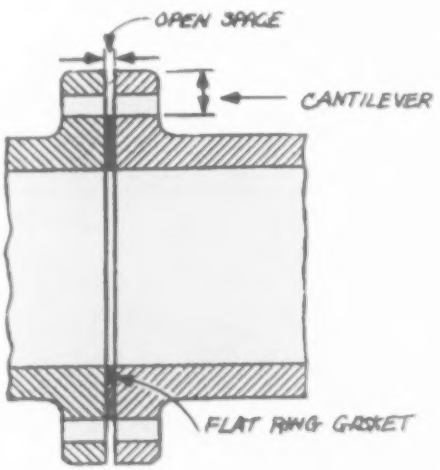


Figure 20-13—Narrow gasket shown here can produce undue stress on flange. Gaskets, therefore, should always cover the full face of the flange.

Lubrication

Proper lubrication can prevent a number of valve problems. A routine schedule is best, but a haphazard program is better than none at all. Stem lubrication with a mixture of oil and graphite should be applied just above the stuffing box. The schedule required will depend on how often the valve is operated and what fluid it is controlling. A frozen valve stem indicates a lack of lubrication. Some valves have oil holes in the yoke cap, some have grease gun fittings, and others have stick lubricant chambers. Records of the various types, along with locations and code tags should be assembled as a means of scheduling inspections and maintenance. Such planning prevents delays in repairing valves and helps in stocking parts.

Any problem that appears to be beyond the scope of the maintenance team should be referred to the contractor, plumbing-heating supply house, or valve manufacturer.

Annual Inspection

Valves should be included in the annual inspection of the heating and ventilating system. See the Annual Inspection Checklist in the Management Tools Appendix.

Refrigerants

Common refrigerants such as R-11, R-12 and R-22 have been used for years in school equipment such as:

- electric water coolers
- food service coolers and freezers
- air conditioning systems
- ice machines

Those refrigerants are "CFC" refrigerants (chlorofluorocarbon) which are gradually being outlawed (per the Montreal Protocol) due to their damage to the environment. No more CFC refrigerant will be manufactured beginning in 1996. Fortunately, used reconditioned refrigerant will undoubtedly be available for many years.

In the long run, CFC using equipment will need to be converted to a "safe" refrigerant or replaced. Often newer equipment can be converted. Usually older equipment should be replaced. In almost every case, new equipment is more energy efficient so the "first cost" of replacement is eventually paid back in energy savings.

Existing equipment can continue to be used; however:

- Refrigerant leaks should be sealed.
- "Blowing the charge" to do service work is now illegal. Refrigerant must be captured and reused.
- Only trained refrigerant technicians should do service work.

Each school should have a Refrigerant Management Plan for an orderly transition to the new refrigerants. The Plan should include an inventory of each existing CFC unit including:

- Manufacturer
- Model number
- Year purchased
- Capacity (tons)
- Charge size
- Leak rate (based on annual amount of refrigerant used to "top off" charge)
- Schedule for conversion or replacement

The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) has numerous publications and standards that can be consulted regarding refrigeration systems.

One key publication is ASHRAE 15-1994 Safety Code for Mechanical Refrigeration. This is a "standard" that is gradually being adopted as a "code" in many municipalities. It principally applies to indoor chillers. It outlines the possible need for:

- Refrigerant leak sensor and alarm panel.
- Exhaust fan to remove escaping refrigerant, activated by the above panel.
- Self-contained breathing apparatus (SCBA) mounted at door.
- Piping of refrigerant safety relief valves to outdoors.
- Restrictions on boilers and other fuel burners located near chillers, etc.

The above Code should be used by a professional engineer to assess each situation.

Temperature Controls

The temperature control system installed in a school building may be from one of several manufacturers and may be one of three types:

- pneumatic
- electric/electronic
- direct digital control (DDC)

The control system's purpose is to automatically regulate the heating, ventilating, and air conditioning systems to provide human comfort as economically as possible.

The temperature control system essentially integrates all of the primary HVAC equipment (i.e., boilers, chillers and cooling towers) so that the system as designed by the engineer operates efficiently while supplying the heating/cooling to meet building comfort needs.

The temperature control system also controls all of the incremental units (i.e., air handlers, unit ventilators, fan coils, roof top units) and integrates them into the overall HVAC system for maximum energy efficiency.

When planning semi-annual maintenance (minimum recommended), it is essential to address both the HVAC system and the controls simultaneously in order to maintain the overall integrity of the building mechanical performance. That is, be sure that boilers and controls are serviced together. Do the same for chiller and controls, air handling units and controls, and so on.

Generally speaking, this integrated approach to servicing HVAC components and controls can be provided by the temperature control contractor or in conjunction with a mechanical servicing company. The temperature control supplier designed and installed the temperature control system and is the most knowledgeable regarding the HVAC system.

Schedules for periodic maintenance are presented in the tables on page 185.

MAJOR COMPONENTS

Room thermostats control valves or damper actuators to regulate heating or cooling as required. They should be kept locked to prevent unauthorized adjustments and should be calibrated at least once a year.

Valve assemblies regulate the flow of heating or cooling in the system, and play a large part in total equipment performance. Valve packing and tight close-off should be checked regularly. See "Valves" beginning on page 178.

Automatic damper actuator assemblies should be checked periodically for loose mounting, mechanical connections to the damper, and diaphragm condition. Outdoor air dampers should be checked for tight closure.

Bulb type thermostats are normally installed on or near the heating/air conditioning equipment and control entering and leaving air temperatures at the unit. They, too, should be kept clean and calibrated and the temperature checked regularly.

Low temperature (freeze) thermostats protect the water and steam coils from freezing during severe weather. This instrument has a 20-foot element and is installed diagonally across the face of the coil surface. It should turn the supply fan off and close outside air dampers when actuated. It is very important to check the operation of the low temperature thermostat periodically. Use cold water or ice cubes to test the device.

Switching relays and accessories—Most systems include a control panel or board that houses the many switching devices required for systems operation. These can be checked only by running the system through its sequence of operation and should be performed by a trained control mechanic.

Air compressor assembly (pneumatic systems only) normally consists of the compressor assembly, refrigerated air dryer, air filter, oil filter, pressure reducing valve and safety valve. Normal storage tank pressure is 80 psi and system pressure is 15 to 20 psi. This equipment must be checked periodically and kept in top working condition. Should any oil or water reach air control lines, serious problems with controls will occur.

SYSTEM ECONOMICS

The following suggestions may be of some value in conserving energy for your system.

1) Use the lowest room thermostat setting that is acceptable for heating and the highest room thermostat setting that is acceptable for cooling.

2) Operate your system on reduced schedules

Maintenance Schedule for Pneumatic Temperature Controls

	Quarterly	Semi-Annually
Air Compressors and Accessories		
Drain and inspect tank	X	
Drain and refill crankcase oil	X	
Oil electric motor		X
Clean and/or replace air intake filter	X	
Check belt tension. Replace worn belt	X	
Inspect and/or replace pressure switch contacts	X	
Check pressure relief valve setting	X	
Check pressure reducing valve setting	X	
Check air lines for moisture, oil and dirt	X	
Check sediment and water trap	X	
Room and Remote Bulb Thermostats and Humidistats		
Check calibration		X
Check throttling range		X
Check air connections		X
Adjust system sequence		X
Dampers and Damper Motors		
Check travel and close off	X	
Lubricate blade and linkage bearings	X	
Check motor connections and spring	X	
Adjust system sequence		X
Valves		
Check operation for tight close off	X	
Lubricate valve stem	X	
Inspect and/or replace packing	X	
Replace disc where necessary		X
Relays, Pilot Valves, Switches		
Check operation	X	
Adjust system sequence		X

Maintenance Schedule for Electric or DDC Temperature Controls

	Quarterly	Semi-Annually
Room and Remote Bulb Thermostats and Humidistats		
Check calibration		X
Check throttling range		X
Check electric connections		X
Adjust system sequence		X
Dampers and Damper Motors		
Check travel and close off	X	
Lubricate blade and linkage bearings	X	
Check electrical connections	X	
Adjust system sequence		X
Valves		
Check operation for tight close off	X	
Lubricate valve stem	X	
Inspect and/or replace packing	X	
Replace disc where necessary		X
Relays, Pilot Valves, Switches		
Check operation	X	
Adjust system sequence		X
Power Supply—Line or Low Voltage		
Current consumption and voltage should be checked with amprobe and compared with original design for potential problems semi-annually.		

at night to keep equipment off as much as possible.

3) Operate mixed air, hot deck and cold deck temperatures of air handling units at most efficient temperatures to prevent excessive cycling, i.e., heating to cooling, cooling to heating.

4) Have outside air intakes checked for amounts that are required and eliminate unnecessary use of outside air during severe weather.

5) Check outside air and relief air openings for tight close-off of the automatic dampers during off periods to prevent infiltration.

6) Schedule regular maintenance for the mechanical system, including the control system.

7) Install thermometers in the inlet and outlet of the supply fan for a quick check on system operation. This will tell you quickly of any failure in the outside air damper or the heating or cooling valves.

21 / Sanitary Systems and Fixtures

A school sanitary system often requires special considerations on the part of the maintenance team. For example:

• **Water usage.** Reduced-flow water closets and other fixtures, because they conserve water, are required in some locales or may be advisable from a purely economic standpoint.

• **Water testing.** The maintenance staff may need to make provisions for the periodic testing of water quality. Such testing is advisable where either the water supply or the school water system is not stable. Testing is required by law or health codes in some areas. See Chapter 6 for more on environmental concerns, including lead in drinking water. The section on "Water Treatment" in Chapter 20 also provides information regarding the chemistry of water that may be useful in addressing problems in sanitary systems.

WATER HEATERS

Types of water heaters most commonly found in schools include the instantaneous, instantaneous with separate storage tank, and storage type heaters.

Instantaneous type heaters consist of coils or tubes through which water passes while being heated. These tubes are subject to the accumulation of mineral deposits, resulting in reduced heat transfer and inefficient operation. Because removal of deposits in the coils or tubes usually requires the use of acids, "deliming" is best handled by an experienced plumber. A trained maintenance staff member can perform deliming, however, by following the manufacturer's instructions and using extreme caution.

For storage tank type heaters, maintenance does not involve deliming procedures but involves the following:

• Drain off a pail or two of water each month to remove silt and sediment. Failure to do this may result in noisy operation of the heater and allow sediment to pass into the water supply lines.

• Check the temperature-pressure relief valve each month to insure that the valve has not become encrusted with lime. Lift the lever at the top of the value several times until the valve operates freely and seats properly without leaking.

• Annual maintenance of water heaters should include shutting off the gas or electric power, removing the main burner or heating element and cleaning the inside of the heating chamber with a wire brush.

• Whenever a building is left unoccupied during cold weather, the water and gas or electric supply should be shut off and the tank drained to prevent freezing. (Whenever water supply is turned off, the gas or electric power supply also should be shut off.)

• Water heaters with power burners should be maintained in accordance with the manufacturer's instructions.

Sanitary Systems and Fixtures, original chapter by F.L. Downs, of Brown, Davis, Mullins and Associates, with update by Richard R. Miller, of Beling Consultants. Third Edition review and update by Glen L. Bellows, of Buchanan, Bellows and Associates, Ltd., Bloomington, IL.

FAUCETS

Most of today's faucets are of the replaceable cartridge type, although faucets with hard rubber or composition gaskets are still being used.

When the cartridge type develops a problem, the entire cartridge should be replaced. Most cartridges are made entirely of plastic. To replace, first close the branch supply valve. Then remove the index or decorative covers; remove the screw that holds the handle to the replaceable cartridge; unscrew the union nut that secures the cartridge to the faucet body, and remove the cartridge. To install the replacement, simply reverse this procedure.

Replaceable cartridge type valves have no springs, no wearing action on rubber gaskets, and no O-rings or packing on the stem to wear or leak. A simple cam activated movement of the diaphragm controls the flow of water. A metering-type replaceable cartridge is basically the same except that it shuts itself off after a certain amount of water has flowed through. The replacement procedure is the same.

A faucet with a hard rubber or composition gasket can develop a leak, as evidenced by water dripping from the faucet. Gaskets wear out and must be replaced. To replace the gasket, the branch supply valve should first be closed. Then remove the handle assembly by unscrewing the union nut and turning the handle counterclockwise until it is freed from its channel. The gasket is held in place by a small screw. Remove the screw and old gasket, place a new gasket on the shaft, and then re-insert the screw and tighten it. The bushing and valve seat should be checked for scars or erosion that could cause a leak.

WATER CLOSETS

Water closets operate by releasing water from a flush tank or from the supply line by means of a flush meter valve. They should be made of a dense impervious material with smooth surfaces to prevent the build-up of deposits. The most common material is vitreous china.

Tank Type: The tank type water closet has a reservoir mounted above the back of the fixture. Water is released from this reservoir to flush the water closet by moving a handle, which lifts a rubber ball from its seat on the discharge pipe. As the water level in the reservoir recedes, a float falls and opens a supply valve. The tank has an overflow pipe to prevent flooding in case the supply valve sticks open. The constant discharge of water to this overflow may require adjusting the float rod to lower the water level. If the float itself is water logged, however, it should be replaced. If a leaking plunger valve is causing the discharge of water, then the thumb screw should be removed from the valve, the rod level taken out, and the plunger removed. A washer at the end of the plunger should be replaced and the valve seat checked and reground if it is cut or scored. Then the assembly should be replaced.

Floats sometimes become water logged because of punctures or leaks around their threads. This prevents their rising as the water level in the tank rises and causes the intake valve to remain open, permitting a continuous flow of water to the tank.

Flush balls are usually made of rubber, are spherical, and have a lift rod screwed into one end. The purpose of the flush ball is to seal the discharge pipe after flushing so that the tank will be refilled.

Both the flush ball and the float can be replaced with new ones by simply unscrewing them from their respective rods and screwing on new parts.

Flush Valves: Flush valves depend upon water volume and pressure for operation. These are metering valves, which complete their cycle and shut off automatically. Flush valves are generally classified into two groups: diaphragm type and piston type. The operation of each is fundamentally the same. Each has an upper chamber and a lower chamber connected by a bypass, which is a small hole no larger than a pinhole. In the diaphragm type, the separation between the two chambers is by a flexible diaphragm: in the piston type, a piston with a molded cup separates the two chambers.

With either type, when the handle of the valve is moved, pressure is released from one chamber, thereby opening the water line and allowing the water to flow into the fixture with sufficient force to flush and cleanse it. While water is flowing from the supply line, a small amount passes through the tiny hole to re-establish pressure in the other chamber, causing the valve to close and shut off the flow of water.

Generally, the only maintenance required to the flush valve is to keep it cleaned, especially the tiny opening between the two chambers. Gaskets, washers, and other rubber or plastic parts wear out and have to be replaced occasionally. Also, in the diaphragm type, diaphragms may have to be replaced every three or four years.

URINALS

Urinals are manufactured as floor mounted or wall hung in a number of sizes and shapes and are most commonly made of vitreous china. As with water closets, flushing is accomplished by means of a flush valve or water tank. The wall hung models are the most popular because of their advantages in cleaning and maintenance.

Siphon-jet and blow-out urinals provide a flushing action and will remove foreign matter such as cigarette butts and gum wrappers. The wash-out and wash-down models are quieter in operation but they are intended to remove liquid waste only.

The automatic flush tank-type urinal consists of a tank mounted on the wall above the urinal with a siphon or upside down U-shaped tube, leading from the tank to the urinal. The siphon discharges water from the tank to flush the urinal as frequently as water fills the tank to a predetermined level. The water supply line to the tank has a throttling valve to control the frequency of flushing by controlling the time it takes to fill the tank.

Siphons sometimes develop leaks, causing loss of air. These must be stopped, because loss of air from the siphon tube will cause it to stop functioning.

To save water, such installations can be modernized by adding manual flush valves.

SHOWERS

Showers consist mainly of a shower head and a shower valve. Shower heads require little maintenance other than occasional cleaning to remove mineral deposits.

Shower valves fall into four classifications: two valve type, the mixing valve (which includes the pressure balanced type), the thermostatic valve, and master control valve system.

The two-valve shower consists of two valves constructed similar to a faucet. The valves have composition gaskets and seats or replaceable cartridges. For replacement procedures, see the section on "Faucets."

The mixing valve consists of a single lever valve which controls the temperature of the shower water. Pressure-balanced mixing valves located in each of the water lines prevents the uncomfortable change in shower water temperature that would follow a sudden reduction in either the hot or cold water supply pressure (usually cold water because of flushing water closets).

The thermostatic valve controls the water temperature by a thermostatic element that moves the hot and the cold mixing parts of the valves. These valves are normally provided with a strainer on the hot and cold inlet supplies to remove any sand, grit, or other substance which may be present in the water mains. The strainer should be cleaned at the first indication of slow response to water temperature variation or when pressure variation is noticeable.

The master control system consists of a thermostatic controller that maintains pre-set tempered water to all hand washing or shower areas. With this system, tempered water is provided to the fixtures at pre-set temperatures; cold water is not normally provided to the fixtures. These valves, similar in operation and construction to the thermostatic mixing valve, should have the strainers checked periodically.

COLUMN SHOWERS

Column shower control valves can be the same as for other showers. Any leakage around the shower head may indicate a hole in the control valve. Because there are usually from three to six shower stations at each column, this will require checking each valve. If the shower head delivers an uneven spray, remove and disassemble it and remove foreign matter. Shower drain cleaning can be accomplished with a plumber's snake inserted through the hand hole of the column.

If the column shower is provided with a push-button metering valve, it will be similar to the faucet metering valve in operation and maintenance.

The time cycle of the metering shower valve may be changed by removing the plug button on the push knob, loosening the alien set screw, and adjusting the travel distance with a thin-blade screwdriver in the center hole of the push knob. Turn the push knob while holding the screwdriver firmly. Turn the knob clockwise to shorten the shower cycle or counter-clockwise to lengthen the cycle. Adjustments may vary with different manufacturers.

Pressure Balancing Valves

The term "pressure balancing" indicates the valve is provided with either a piston or a diaphragm that equalizes pressures between the hot and cold water supplies. (The cold water usually

varies the most because of the operation of flush valves on urinals and water closets.) When operating properly, the hot water will not flow if the cold water supply to the valve is shut off, thereby reducing the possibility of scalding bathers. To service the pressure balancing valve, first open it to about the warm position. Then loosen the handle screw and remove the handle. Remove the escutcheon, unscrew the dial locknut and remove the dome cover. Then unscrew the valve cap with the complete assembly. Leave the packing nut in place while unscrewing the cap to avoid distorting the end of the cap. When the cap is unscrewed, the entire working unit may be removed.

The perforated cylinder is an integral part of the spindle and it does not unscrew. The cylinder is hollow and contains a piston; the piston is free moving and provides the pressure balancing feature of the valve.

The piston should move freely inside the cylinder at all times, and should click back and forth when the assembly is shaken. After long service in rugged waters, mineral or other deposits may block the piston's action.

Normally, tapping the handle end of the spindle against a solid object will free the piston. If it is so solidly plugged that this is not effective, replace the entire spindle assembly.

Ordinary service requires only the replacement of hot and cold water washers. It is essential that both hot and cold washers be replaced at the same time, even if only one appears to require attention. Use only pressure balanced valve washers. When reassembling the valve after any repairs, be sure that the cylinder is drawn close to the cap before screwing the cap back into position.

Thermostatic Valves

Most thermostatic valve repair involves changing the slip ring and the power element. Usually these operations will eliminate temperature fluctuations. Disassemble valve top, spring, main valve slide and power element. Handle the power element cautiously so as not to damage.

Take a pocket knife or some pointed object and remove the old slip ring. Insert a new slip ring into the recess or channel. Install the power element. Apply grease to the main valve slide and gently ease it into position. Rotate the slides as grease is applied to the slip ring. Do not force as this could push the ring out of its socket. To test, rotate the slide and if it is properly in position, a slight drag will be felt. Reassemble the remainder of the valve.

If no hot water is available, check the source of supply for corrosion which may have closed the supply line.

To prevent foreign matter from getting into the thermostatic valve and causing problems, it is often protected by a strainer check-stop. Shut off the screwdriver stop, remove and clean the strainer, and inspect the check-stop for smooth operation.

DRINKING FOUNTAINS

Drinking fountains (non-refrigerated) are manufactured from many different materials, the most common being vitreous china, enameled cast iron, precast stone and stainless steel. They may be surface mounted, semi-recessed, or fully recessed.

All three types are provided with a stop fitting, usually screwdriver operated, which is used to shut off the flow of water to the fountain and to adjust the height of the bubbler stream. The adjustment is made from below on all but the fully recessed type, which has an access cover plate on the front.

The bubbler is controlled from a self-closing valve, which is either a spring-return handle or push button. The latter operates by compressing a spring and a washer and seat. The most common type of bubbler operator is a compressed spring that keeps pressure against two cams separated by a ball race or ball bearing. As the handle is turned, the cams operate against each other with the aid of the bearing, opening and closing the valve against the seat.

The bubbler height should be adjusted so the stream arches up above the bubbler saliva guard so that the mouth of the user need not touch the guard.

ELECTRIC WATER COOLERS

Electric water coolers are manufactured from the same materials as drinking fountains. They consist of a refrigeration unit that cools the water to approximately 50 degrees F.

Adjustment of the bubbler stream usually requires removal of the valve handle (which is secured to the valve by an allen-type set screw) and unscrewing the bubble stream nozzle. The bubbler saliva guard can then be removed. To adjust the stream height, reconnect the stream nozzle,

without the saliva guard and valve housing. An adjustable pressure regulator is a part of the bubbler valve and has a screwdriver adjustment for regulating the pressure (stream height).

Keep in mind that many times the bubbler stream can be adjusted by adjusting the supply stop. However, if water pressure exceeds 50 psi, adjust pressure to the regulating valve, as excessive pressure will wear the stop.

A remote water cooler is a term used for refrigeration units that are not housed within the drinking fountain enclosure. Units of this type pipe the chilled water from the refrigeration unit to a drinking fountain as previously described. It is important that the piping between the remote cooler and the drinking fountain be well insulated to maintain the desired temperature, to prevent excessive operation of the remote unit, and to prevent the water in the atmosphere from condensing on the cold pipe and dripping.

Other than making sure that dust and dirt do not accumulate within the cabinet, which reduces cooling efficiency, little maintenance is required.

WASH FOUNTAINS

Wash fountains come in a variety of materials, including stainless steel and molded stone. Sizes range from semicircular to circular and from free-standing to wall hung and are foot or hand operated.

Valves controlling the temperature of water for wash fountains are normally the manual mixing valve or the thermostatic type mixing valve similar to those for showers.

Periodic cleaning of spray heads is recommended. Frequency depends upon the mineral content of the water. To clean, remove the wing or hex-nuts, drop the lower spray head ring and clean out chips and other foreign material with a wire brush. Lime build-up can also be removed in this manner.

GREASE INTERCEPTORS

Every interceptor should be accompanied by the manufacturer's cleaning and maintenance instructions. It is helpful to have an instruction plate on the cover that specifies at least these requirements:

1. Remove grease and solids carefully; *do not* flush it down the sewer.
2. Replace all baffles correctly.
3. Secure the cover tightly.
4. Clean at regular intervals depending on load.

Many products are promoted as aids to cleaning grease interceptors. These include caustics and acids with their known hazards in handling. They include so-called "miracle enzymes" with their limited conditions and special instructions. There are self-cleaning interceptors with their complicated operating instructions. Even solids evacuating types of interceptors must be cleaned periodically.

Greases and oils present different characteristics. Saponifiable greases combine with caustics to form soaps. You can tell when a caustic has been used to clean a grease interceptor because a dry, hard matter will be exposed on the surface—soap—when the cover is removed. (Mineral or petroleum oils do not form soaps.) This soap forms an obstruction in the drainage line, which is joined by particles of solids to gradually increase the size of the obstruction.

Cover gaskets are necessary to seal out odors and prevent excessive surges that cause overflows. Covers must be easily removed or they will not be cleaned as regularly as they should be. A cover with eye bolts and nuts that swing down to remove the cover is easy to open. A non-ferrous bolt is best when the interceptor is set in the floor. The threads on a brass bolt are easily stripped while steel bolts rust easily.

ACID NEUTRALIZATION BASINS

Limestone (marble) chips are used to help neutralize and/or dilute chemical bearing wastes (such as acids). State environmental and plumbing codes call for the addition of limestone chips into acid neutralization basins. Water is also added to the tanks to initiate the dilution process.

For proper performance, limestone must be in the one to three inch (1" to 3") diameter size range and must contain a calcium carbonate content in excess of 90 percent.

The effective ingredient in limestone is calcium carbonate. This chemical compound reacts with acids to form harmless neutral salts, carbon dioxide and water. The neutral salts usually precipitate into a sludge, which falls to the bottom of the tank. Carbon dioxide gas mixes with water to form carbonic acid, which helps to neutralize alkaline (caustic) wastes. The water, of course, helps to dilute the acidic, alkaline and solvent wastes.

Tanks should be inspected routinely to deter-

mine if the precipitated sludge, debris and other material must be cleaned out (usually scooped out) and for periodic addition of limestone and water. Normally, once every three months is sufficient for tank inspection and maintenance. Because more or less frequent inspection may be called for in some cases, professional assistance should be sought to establish the correct inspection and maintenance schedule for a system.

22 / Sewage Treatment Plants

The sewage treatment plant must be given regular and proper attention. It is a substitute for municipal sanitary sewers and sewage treatment plants.

Proper maintenance and operation is necessary. Neglect or improper maintenance may necessitate complete reconstruction of the plant in a relatively short time. Objectionable odors and unsanitary conditions will result from improper operation.

Maintenance Manual: A detailed maintenance manual for the specific system should be available for reference. The manual may be developed or provided by the system supplier or locally developed from instructions provided by all involved vendors.

Processes: Private sewage treatment plants employ a variety of unit processes that can be arranged in a variety of combinations and configurations. In general, private sewage treatment plants fall into two categories: those using a septic tank or those using some form of aerobic biological treatment. The diagrams in *Figure 22-1* show several treatment systems. The treatment systems shown all include solids removal and biological treatment, either aerobic or anaerobic, to reduce the dissolved organic matter content of the sewage.

In addition to proper operation and maintenance, the sewage treatment plant must be designed and built properly if it is expected to perform properly. All sewage treatment plants must be installed and operated in strict accordance with the requirements of the State's Environmental Protection Agency.

SEPTIC TANKS

A septic tank (*Figure 22-2*) removes settleable and floatable solids from sewage. The solids that settle to the bottom form sludge. The solids that float to the liquid surface form a scum layer. All solids retained in the septic tank are subjected to anaerobic biological decomposition. This reduces the quantity of organic solids by biological conversion to water, gas and energy (cell reproduction). The bacteria necessary for most biological sewage treatment processes are normally found in domestic sewage.

Maintenance

Inspect septic tanks at least twice a year. Check baffles or pipe fittings. They should be in place at inlet and outlet. These baffles or pipe fittings prevent scum and solids from entering the outlet sewer and prevent currents across the tank.

Cleaning

When total depth of scum and sludge exceeds one-third the total depth of the tank, it must be cleaned. Frequency of cleaning depends upon the size of the tank and the daily flow. Garbage disposals increase cleaning frequency. No chemical or digesting yeast will completely clean a septic tank. Sludge can be removed only by special cleaning equipment and should be removed and

Sewage Treatment Plants, original chapter by Walter G. Kimmel, of Kimmel-Jensen-Wegerer-Wray, with materials from Brown, Davis, Mullins and Associates and the Ohio Trade and Industrial Education Service, and updated by Henry Mayer and James Merchie, of Beling Consultants. Third Edition review and update by Glen L. Bellows, of Buchanan, Bellows and Associates, Ltd.; William C. Symounds, of Diversity Water Technologies, Inc., and Donald Merritt, of Farnsworth and Wylie Engineers.

Various Treatment System Schematics

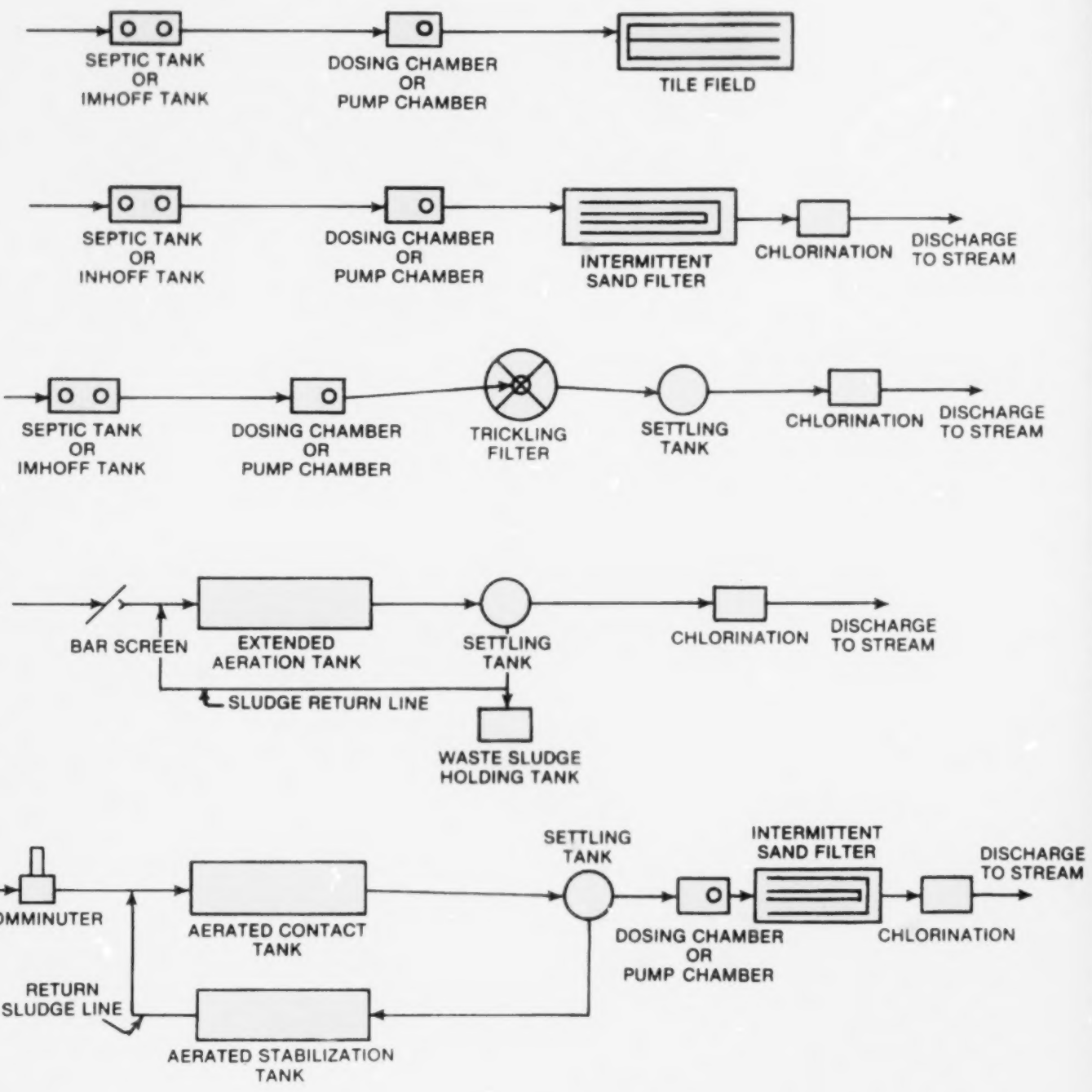


Figure 22-1—Diagrams show five different sewage treatment systems.

disposed of by a licensed special waste hauler. Call the health department for help in obtaining this service.

Following is a section from the "Manual of Septic Tank Practice" as published by the U.S. Department of Health:

> Chemicals—The functional operation of septic tanks is not improved by the addition of disinfectants or other chemicals. In general, the addition of chemicals to a septic tank is not recommended. Small amounts of chlorine bleaches, added ahead of the tank, may he used for odor control and will have no adverse effects. Small quantities of lye or caustics normally used in the home, added to plumbing fixtures is not objectionable as far as operation of the tank is concerned. If the septic tanks are as large as herein recommended, dilution of the lye or caustics in the tank will be enough to overcome any harmful effects that might otherwise occur.
>
> Soaps, detergents, bleaches, drain cleaners, or other material, as normally used in the household, will have no appreciable adverse effect on the system. However, as both the soil and essential organisms might he susceptible to large doses of chemicals and disinfectants, moderation should be the rule. Advice of responsible officials should be sought before chemicals arising from a hobby or home industry are discharged into the systems.

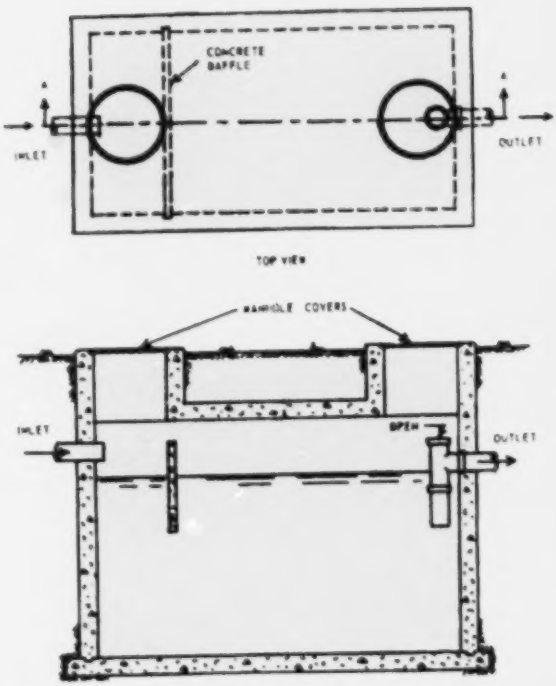


Figure 22-2—Septic tank.

IMHOFF TANKS

Whereas the septic tank has only one level or story, the Imhoff Tank (*Figure 22-3*) consists of two stories to provide both solids removal and digestion. This arrangement allows minimum contact between the sewage and the settled, digesting sludge and the detention period is reduced. Imhoff Tanks can be either circular or rectangular and are divided into three chambers: the upper section called the flow-through chamber or settling compartment; the lower section known as the sludge digestion chamber; and the gas vent and scum chamber at the edges of the tank.

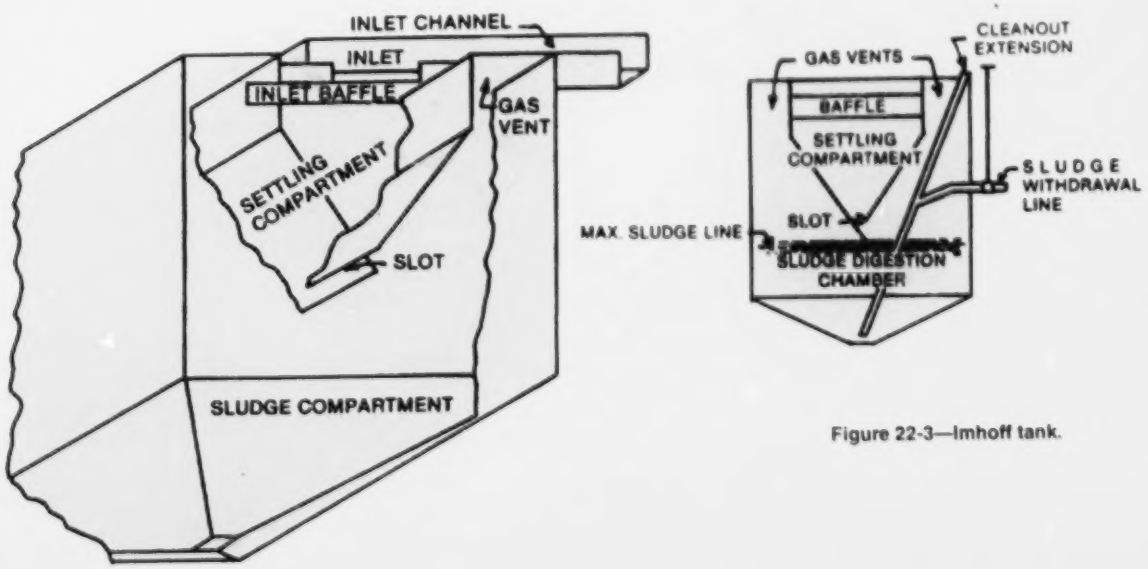


Figure 22-3—Imhoff tank.

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Sewage flows through the upper compartment and solids settle to the bottom. The bottom of the flow-through chamber is sloped so that accumulated solids can slide down to the opening at the bottom. One of the bottom slopes extends at least six inches beyond the opening. This forms a trap to prevent gas or digesting sludge particles in the lower section from entering the upper flow-through section. The gas and any rising sludge are diverted to the gas vent and scum chamber. This eliminates the main disadvantage of septic tanks.

Piping is provided for withdrawal of sludge from the lower chamber. After sludge withdrawal, the pipes should be flushed and filled with water or sewage to prevent sludge from clogging the pipe. All sludge should be disposed of properly. The Imhoff Tank has no mechanical parts and is relatively easy and economical to operate. Some suggested maintenance steps for Imhoff Tanks are as follows:

1) Remove scum and floating materials from the upper flow-through chamber daily or as needed.

2) Scrape the sides and sloping bottom of the upper compartment weekly or as necessary to remove solids adhering to the lower digestion chamber.

3) Clean the slot at the bottom of the upper chamber weekly or as needed. This can be done with a drag chain.

4) Scum from the scum chamber should be removed and properly disposed of as needed, usually when the layer approaches two feet thick.

5) Sludge removal from the lower digestion chamber should be done frequently in small amounts rather than in large amounts at long intervals. Sludge withdrawal should be done slowly to prevent the formation of a channel through the thick sludge which would allow partially digested sludge and liquid to be withdrawn. Just before winter, about 75 to 80 percent of the sludge should be withdrawn to provide volume for winter storage when digestion is slowed by lower temperatures.

DOSING CHAMBER

Sewage flows from the septic tank and accumulates in the dosing chamber; then, at a preset water level, a siphon automatically discharges sewage to a tile field or an intermittent sand filter. There may be one or two siphons in the dosing chamber. If there are two siphons, they may alternate automatically every time the dosing chamber fills. (See *Figure 22-4.*)

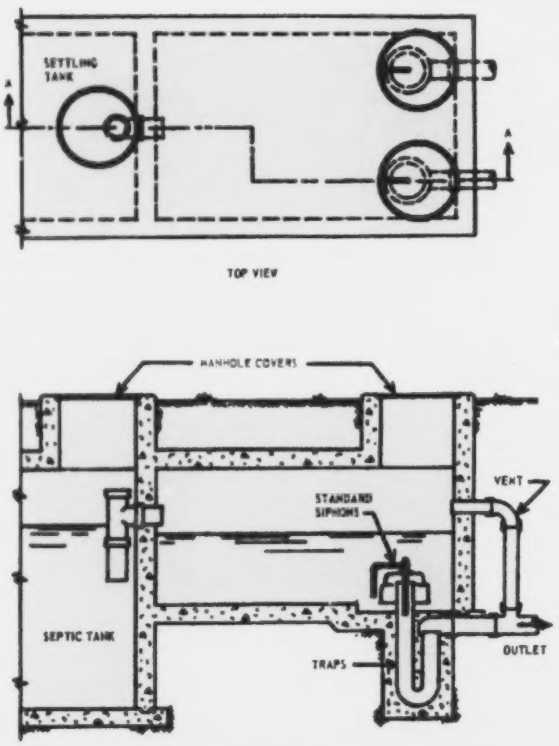

Figure 22-4—Dosing chamber with alternating siphons.

Inspection

Inspect siphon operation twice each week or as experience dictates. The dosing chamber must fill to a level about three inches below the overflow pipe and then empty rapidly. Otherwise, siphons are not operating properly.

Siphons must operate automatically and alternately. They should discharge from one to four times daily depending on the flow.

Operation for Starting Siphon

1) Remove the bells.
2) Make certain the main traps are clean.
3) Fill the traps of both siphons with water.
4) Make certain bells are replaced tightly on traps to prevent the escape of air.

Check Traps

1) The idle trap may refill when the other siphon operates. There are several possible

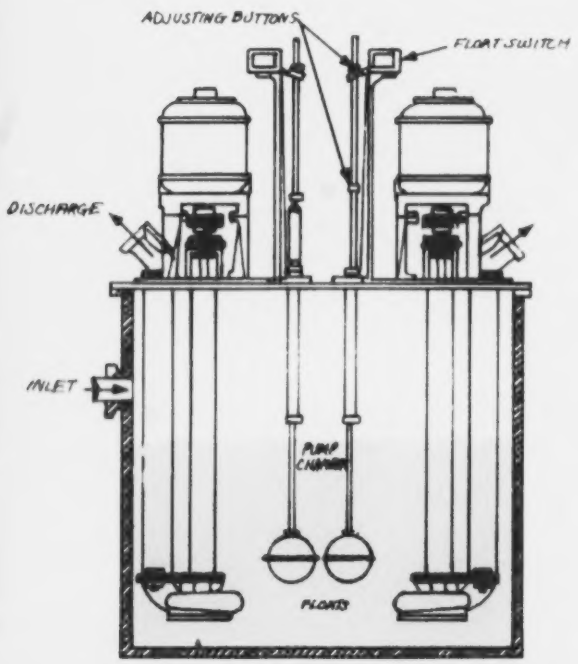

Figure 22-5—Pump chamber with alternating pumps.

causes:

- A leak in the floor or discharge line.
- Backing up of sewage into the discharge line from the manhole or filter beds.
- Clogged Discharge line.

2) Make certain the outlet from each siphon is free.

PUMP CHAMBER

Sometimes alternating pumps are substituted for siphons in a wet well. (See *Figure 22-5.*) Dual pumps are operated alternately by a float controlled automatic switch. The pump chamber requires the following service:

Pumps and Motors

1) Follow manufacturer's lubrication instructions.

2) Allow good ventilation for motors to prevent condensation.

3) Check daily for overheating of the motors.

Float Controls

1) Inspect the float control daily.

2) Replace if the float or float rod is badly corroded.

3) If switch is out of adjustment, a skilled workman may be needed to make repairs. Consult the manufacturer.

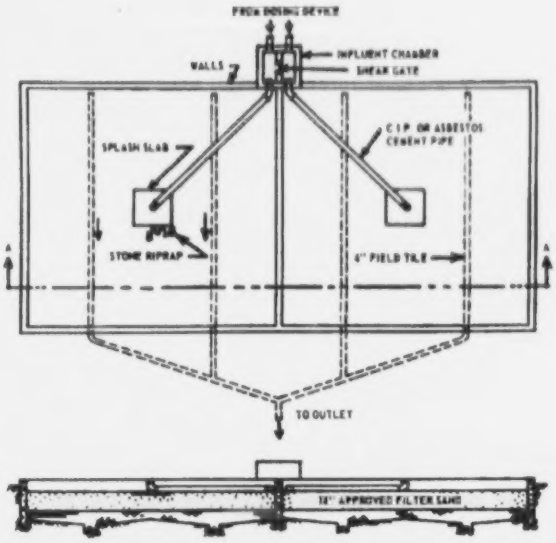

Figure 22-6—Intermittent sand filter dosed by flooding.

Cleaning

1) Clean the screen if clogged with grease and suspended matter.

2) Clean the chamber as required.

INTERMITTENT SAND FILTERS

Intermittent sand filters (*Figure 22-6*) consist of sand and gravel layered in a bed through which the sewage seeps. The sand filters are intermittent because they are normally dosed and allowed to drain before being dosed again. If parallel filters are used, alternate dosing is generally done by automatic alternating dosing siphons or pumps.

The filtered sewage (filtrate) is collected in open jointed drain piping beneath the filter bed. The sand filter removes solid matter and also acts as a fixed media biological treatment unit when operated properly.

Check Daily

Surface sand filters should be regularly checked for clogging—every day if necessary—which is indicated when sewage remains on the surface of the sand longer than 30 minutes. Clogging is caused by solids and grease from the previous treatment unit. Observe the sewage in

the influent chamber. Liquid should be fairly clear and free of visible solid matter.

Debris

Clogging may be caused by weeds, leaves, and other surface debris. If necessary, build a fence around filters to prevent trespassing and dumping of rubbish. Pave the slopes of surrounding banks or build a tight wall to keep soil and other surface wash off the beds. Pull out weeds and roots.

Sewage Distribution

Large volumes of sewage must be dosed into the filter beds. Don't allow sewage to trickle into the bed continuously. Keep the sand raked level and adjust the inlet for even distribution. Distribution troughs, tile, or pipe are needed for even distribution.

Overloading

Clogging may be caused by applying too much sewage to the filters. Loading rates and estimated flows may be verified by contacting the State Environmental Protection Agency.

The wrong kind of sand also will clog filters. Only use sand approved by the state department of health.

Remedies for Ponding

If sewage is not absorbed, divert the flow to the second filter. Allow the sand to dry thoroughly. Scrape the thin crust off the surface after the filter bed has dried. Do not use a rake or rotary tiller before all foreign material is removed. If sewage still ponds, take the filter bed out of service again and allow the sand to dry completely. Remove an inch or two of encrusted sand with a flat shovel. This should be done about once a year or when necessary. When sand has been reduced by about four inches, add clean, approved filter sand to original depth. The state department of health will furnish specifications for the sand and test it for suitability.

TILE FIELDS

Tile fields can be used as an ultimate disposal method where climate and soil conditions permit (*Figure 22-7*). Tile systems receive settled sewage from the septic tank either on a continuous basis or dosed in a similar manner as sand filters. The sewage flows into the open-jointed tiles and drains into the sand and gravel bedding. The tile field has two feet of earth over the media to prevent surface saturation. Effluent sewage seeps into the ground, being treated by the microorganisms living in the soil. Some water is also lost to evaporation and plant transpiration, depending on seasonal changes.

Overloading

The tile field may clog if improperly treated sewage is allowed to enter. Solid material can plug the soil pores, greatly reducing the soil absorption rate. The septic tank should be checked for excess solids accumulation if this is suspected. Soil saturation by higher groundwater levels or heavy rainfall may also reduce capacity of the soil. Surface runoff water should be diverted away from the tile field area.

Maintenance

Routine maintenance for tile fields includes proper operation of the septic tank to insure proper solids removal. The tile field area should be kept free of debris and planted in grass. The grass should be kept short to facilitate maximum evaporation. Vehicles should be kept off of the tile field to prevent compaction of the soil and damage to the piping.

TRICKLING FILTERS

A septic tank is necessary ahead of the trickling filter in order to prevent clogging of filter nozzles. A trickling filter is a bed of stone or slag over which sewage is distributed by rotating arms or fixed spray nozzles (*Figure 22-8*). As the sewage trickles through the filter bed, the organic matter in the sewage is captured and digested by the aerobic microorganisms that grow as a slime on the filter rock. A drain system collects the sewage as it comes out the bottom of the trickling filter and provides necessary air circulation up through the filter bed.

Ordinarily a trickling filter will slough; that is, the biological solids will break away from the rocks, peaking in the spring and fall of each year. These solids must be removed from the final settling tank daily, either by pumping them to the first settling tank or by pumping them to a sludge holding tank for proper disposal.

Rotary Distributors

Rotary distributors are used on some surface sand or trickling filters (*Figure 22-9.*) The sewage

is evenly distributed over the filter through holes or nozzles in the arms. The distribution arm rotates by means of hydraulic pressure created by the jets of sewage leaving the nozzles.

Trickling filters must be inspected regularly for ponding.

Causes of Ponding

1) Sewage on the filter must contain dissolved oxygen to encourage growth of aerobic bacteria. Overloading sometimes depletes oxygen, causing ponding and odors.

2) An accumulation of leaves on the filter.

3) Unsatisfactory stone or slag.

4) Excessive amounts of grease and solid matter from the septic tank.

5) Improper care of septic tank. Clean it regularly.

Remedies for Ponding

1) Rake or fork the surface.

2) Punch holes in the top layer.

3) Rest the filter several days.

4) Flush the surface with a high pressure stream of water.

5) Replace small size stones with approved stone or slag.

6) Dose filter with chlorine to kill excess bacterial growth.

Maintenance

1) Check the turntable for binding.

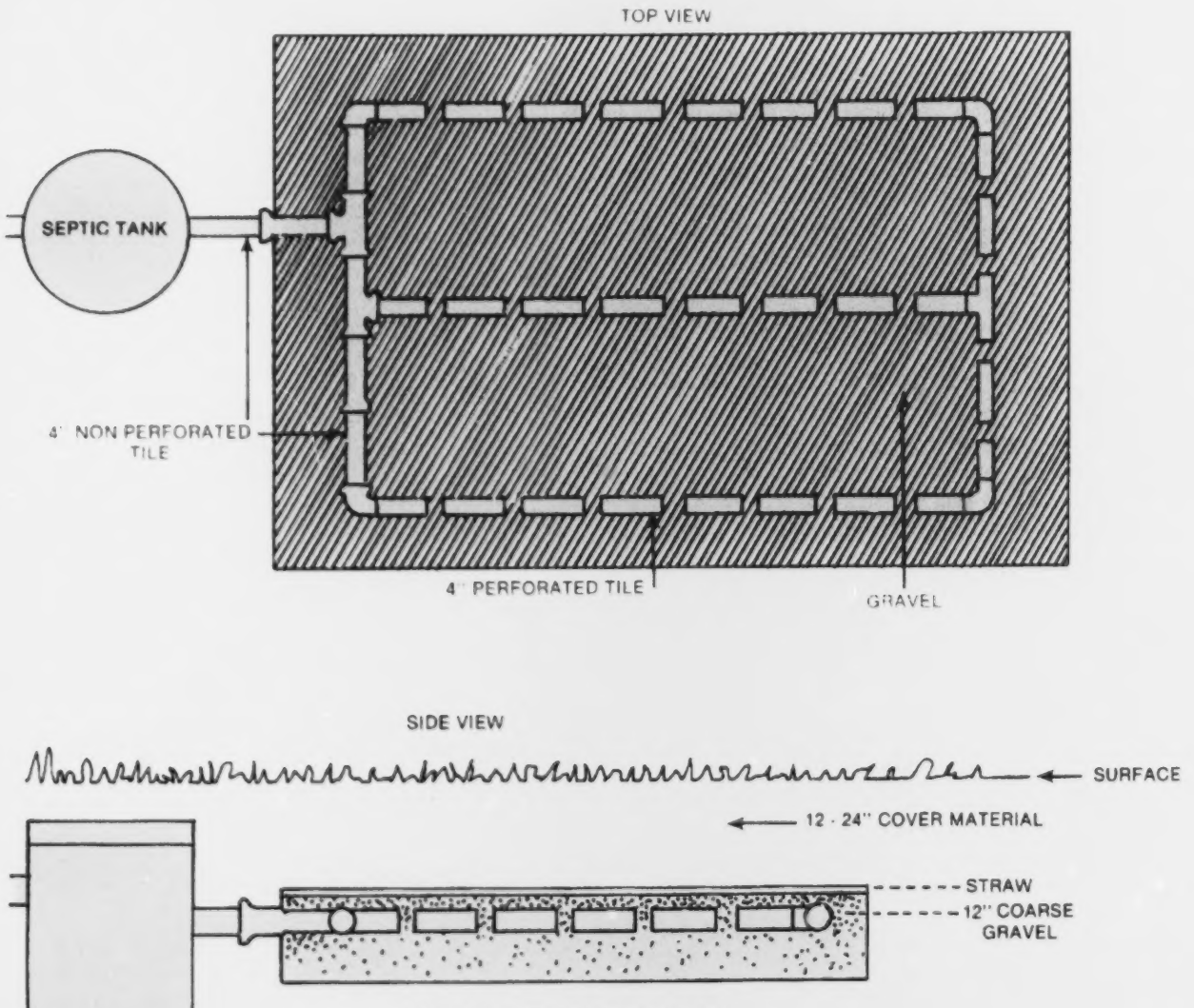

Figure 22-7—Two views of a tile field.

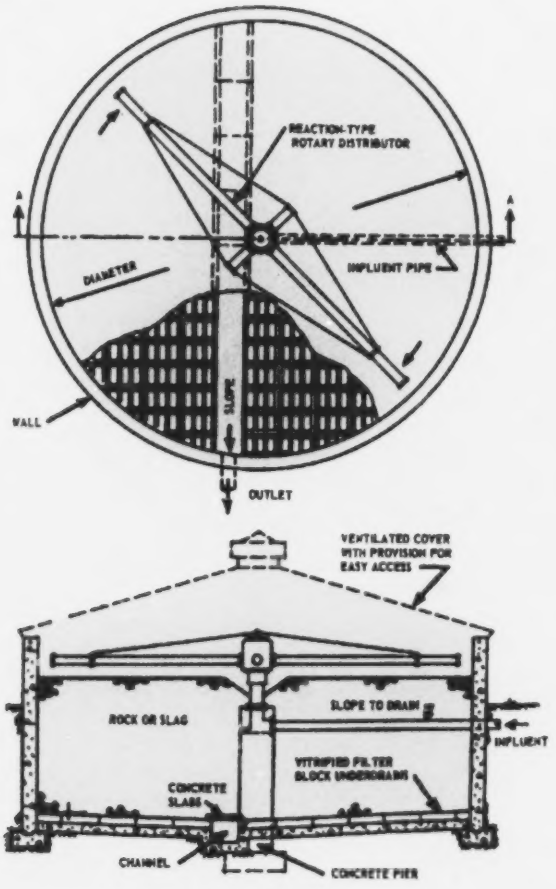

Figure 22-8—Trickling filter.

2) Follow manufacturer's recommendations for lubrication and cleaning the media.

3) Inspect and clean nozzles daily. If holes are clogged, distribution of sewage will be uneven and result in clogged filters. It may lead to the breeding of insects in the trickling filter.

4) Open the covers at the ends of the arms and flush the arms daily while the equipment is operating.

5) Keep the septic tank in good condition. Clean it regularly.

LEACHING WELL

A leaching well is a hole in the ground, walled with brick, concrete block, or stone (*Figure 22-10*). It allows liquid from the septic tank to seep into the subsoil in much the same way as a tile field.

Clogging of the leaching well may be caused by solids and grease from the septic tank. Proper septic tank care is extremely vital; clean it regularly

When the subsoil becomes so saturated with sewage that leaching will no longer take place, it is necessary to build a new one.

ACTIVATED SLUDGE

Aerobic biological treatment systems use the organic matter in sewage as a source of food for cell reproduction. The most common types of aerobic biological treatment systems include **trickling filters** and **activated sludge systems**.

Trickling filters are discussed above. This section will focus on the more common types of activated sludge systems. The common components of an activated sludge system are:

- Preliminary treatment
- Aeration tank
- Settling
- Sludge holding
- Chlorination

1) Preliminary treatment removes large solid materials from the sewage. Two ways of doing this are with a bar screen or a comminutor.

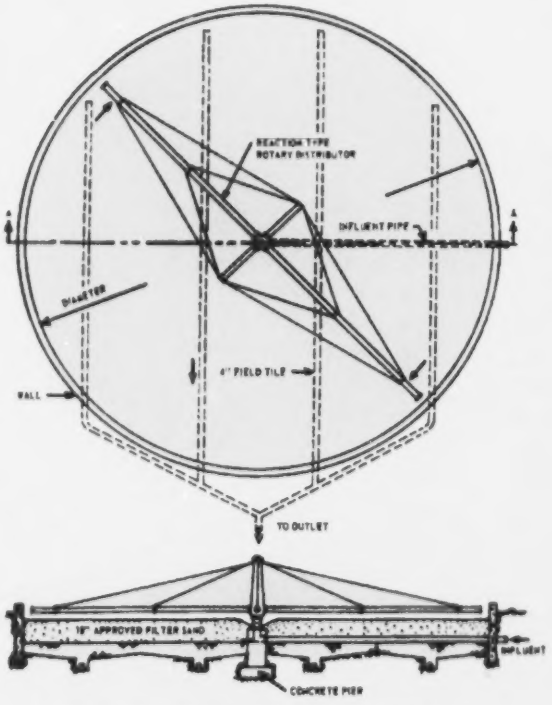

Figure 22-9—Rotary distributor on sand filter.

BEST COPY AVAILABLE

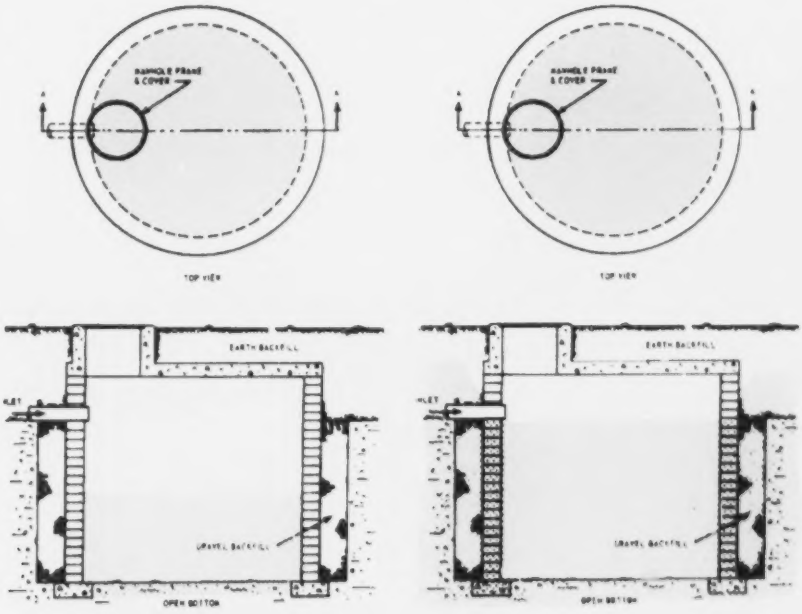

Figure 22-10—Leaching well (left) and saturated leaching well (right).

A bar screen is simply a row of vertical steel or aluminum bars set into the flow stream. The openings between the bars are usually about one inch wide. The bar screen is usually set in the flow stream at an angle to make cleaning easier. When screenings accumulate, they should be removed from the bar screen with a rake or fork and properly disposed of by burial or burning. This should be done daily or more often if necessary.

Comminutors are used to grind solid material into small pieces so that pumps and piping won't be plugged or damaged. The comminutor consists of a stainless steel basket submerged in the flow stream. As the sewage flows through the comminutor basket, solid materials are captured. The basket has openings in the range of 1/4-inch. An electric motor on top of the comminutor drives the cutting blades which are mounted on a vertical shaft extending down from the motor. The cutting blades grind the captured solids against the steel basket and return them directly to the flow stream when they are small enough to pass through the basket. Comminution leaves no solids to dispose of.

Manufacturer's lubrication instructions should be followed, and submerged parts should be inspected once or twice a year to check for broken cutting blades and clogging.

2) The aeration tank is the heart of the activated sludge plant. This is where the decomposition of the organic matter in the sewage takes place. In the presence of oxygen, the microorganisms and the sewage are mixed. As the microorganisms eat the organic matter, grow and reproduce, the individual organisms clump together (flocculate) to form an active mass of microbes called "activated sludge." In practice, the sewage flows continuously into the aeration tank where air is injected to mix the activated sludge with the sewage and to supply the oxygen needed for the microbes to break down the organic matter. The mixture of activated sludge and sewage in the aeration tank is called "mixed liquor" or "mixed liquor suspended solids" (MLSS).

The mixed liquor flows from the aeration tank to a settling tank where the activated sludge is settled out. Most of the settled sludge is returned to the aeration tank to maintain a high population of organisms to permit rapid, efficient break down of the organics. Because more activated sludge is produced than can be used in the process, some of the return sludge is diverted or "wasted" to the sludge holding tank for disposal.

The two most common variations of the activated sludge process in use in private treatment plants are the "extended aeration" and "contact stabilization" processes. Extended aeration takes its name from the relatively long retention time in the aeration tank. The mixed liquor is aerated for about 24 hours before flowing to the settling tank. The long aeration period allows the activated sludge that forms to be partially digested within the aeration tank, thus reducing the volume of excess sludge for disposal. Sludge from the settling tank is returned to the aeration tank at a rate of 50 to 200 percent of the sewage flow rate.

Some Sewage Treatment Terms

Employees who are responsible for maintaining sewage treatment plants encounter a great deal of technical terminology. Here is a glossary of some of the essential terms used in this chapter—terms that responsible employees will need to understand.

Absorption: Taking in or reception of one substance into the body of another by molecular or chemical action, and distributed throughout the absorber.

Activated Sludge: Sludge particles produced in raw or settled wastewater (primary effluent) by the growth of organisms (including zoogleal bacteria) in aeration tanks in the presence of dissolved oxygen. The term "activated" comes from the fact that the particles are teaming with bacteria, fungi, and protozoa.

Aerobic: A condition in which "free" or dissolved oxygen is present in the aquatic environment.

Anaerobic: A condition in which "free" or dissolved oxygen is not present in the aquatic environment.

Anaerobic Bacteria: Bacteria that live and reproduce in an environment containing no "free" or dissolved oxygen. Anaerobic bacteria obtain their oxygen supply by breaking down chemical compounds which contain oxygen, such as sulfates (SO^4).

Bacteria: Bacteria are living organisms, microscopic in size, which consist of a single cell. Most bacteria use organic matter for their food and produce waste products as the result of their life processes.

Biochemical Oxygen Demand or BOD: The BOD indicates the rate of oxygen utilized by wastewater under controlled conditions of temperature and time.

Coliform: The coliform group of organisms is a bacterial indicator of contamination. This group has as one of its primary habitats the intestinal tracts of human beings. Coliforms also may be found in the intestinal tracts of warm-blooded animals and in plants, soil, air and the aquatic environment.

Dissolved Oxygen: Atmospheric oxygen dissolved in water or wastewater, usually abbreviated DO.

Distributor: The rotating mechanism that distributes the wastewater evenly over the surface of a trickling filter or other process unit.

Effluent: Wastewater or other liquid—raw, partially, or completely treated—flowing from a basin, treatment process, or treatment plant.

Inorganic Waste: Waste material such as sand, salt, iron, calcium, and other mineral materials which are not converted in large quantities of organism action. Inorganic wastes are chemical substances of mineral origin and may contain carbon and oxygen.

Organic Waste: Waste material which comes from animal or vegetable sources. Organic wastes generally can be consumed by bacteria and other small organisms and contain mainly carbon and hydrogen along with other elements.

Septic: A condition produced by the growth of anaerobic organisms. If severe, the wastewater turns black, giving off foul odors and creating a heavy oxygen demand.

Sludge: The settleable solids separated from liquids during processing or deposits on bottoms of streams or other bodies of water.

Many small extended aeration plants are sold as prefabricated plants which are compartmented into aeration zone and settling zone.

Contact stabilization is a variation of the activated sludge process developed for applications where space is limited. The process consists of the "contact" (or aeration) tank where the activated sludge and sewage combine to form mixed liquor. Retention time in the contact tank ranges from 30 to 90 minutes. This is just long enough for the microbes to absorb the organic matter from the sewage but not long enough to allow them to be broken down. The activated sludge is then settled in the settling tank and put into the "stabilization" (reaeration) tank. Retention in the stabilization tank can range from 2 to 5 hours to permit the organisms to digest the absorbed organics. Because the settled volume of the activated sludge being aerated in the stabilization tank is much smaller than the total sewage flow, the total size of the plant is reduced.

Excess sludge generated by contact stabilization is generally wasted from the stabilization tank either to a separate sludge holding tank or

directly to disposal. Sludge is returned from the stabilization tank to the contact tank at a rate of 50 to 150 percent of the incoming sewage flow.

Air for activated sludge systems is usually supplied by blowers. The air is introduced to the aeration tanks by a series of pipes, control valves and diffusers. The air must be properly distributed to maintain adequate mixing and oxygen supply throughout the tank. Package plants are generally supplied with two blowers, each having sufficient capacity to provide the total amount of air required.

3) All activated sludge systems require solids removal after the aeration tank. A settling tank is usually provided to separate the activated sludge from the "clarified effluent" which is discharged for further treatment. As previously described, the activated sludge is drawn from the bottom of the settling tank or "clarifier" to be returned to the aeration tank or to be wasted. Sludge return to the aeration tank (or contact tank in the case of contact stabilization) is usually continuous, with the rate of flow being controlled by manual adjustment. Wasting sludge from the system is done manually by opening a valve on a gravity drain line or turning on a pump. In a package plant where the clarifier is integral with the aeration tank, air lift pumps are usually provided which operate on the blower air supply. An air feed valve on the pump controls the rate of pumping.

The metal plate over which the effluent flows is called a "weir." The purpose of a weir is to control the velocity of the effluent as it leaves the clarifier. If the velocity is too high, sludge particles may not settle and be carried out with the effluent. Thus, the solids removal efficiency of the unit is lost. Weirs should be set dead level. Weirs commonly have flat or saw-tooth edges. In general, the longer the weir, the lower the velocity for any given flow rate.

A baffle is usually located in front of the effluent weir and extends below the water surface. This blocks floating materials and scum from flowing out with the clarified effluent.

4) An activated sludge plant should have some type of sludge holding tank. In contact stabilization systems, the reaeration tank serves the dual purpose of stabilization and sludge holding tank. Sludge is both returned to the aeration tank, usually on a continuous basis, and wasted to disposal from the stabilization tank.

A separate holding tank, either aerated or nonaerated, is needed with extended aeration systems. Excessive sludge quantities are not as large with extended aeration as with other forms of activated sludge processes, but periodic wasting is still necessary for good performance.

Sludge holding tanks are constructed of reinforced concrete, concrete block, steel, or impervious earthen lagoons.

Under circumstances where a higher degree of solids removal is required, the settling tank may be followed by a dosing or pump chamber with intermittent sand filters. These units are similar to those described in the section on septic tank systems.

5) State and federal regulations limit the number of bacteria that can be in treated sewage effluent which is discharged to the surface. For most treatment systems, this requires some type of disinfection. In small private plants, some form of hypochlorite is usually used.

Sodium hypochlorite (liquid bleach) is fed into the wastewater at a controlled rate by either a control valve or a metering pump from a large plastic solution tank. Calcium hypochlorite (dry chlorine as used in swimming pools) comes in two forms—powder and tablets. The powdered form is usually mixed with water in a plastic solution tank and fed into the sewage, as is the sodium hypochlorite. The solution tank should hold a 7 to 30 day supply of chlorine solution. Automatic chlorinators being marketed use tablets of calcium hypochlorite stacked in a plastic contact chamber. The unit has a slot at the outlet side that controls the level of sewage in the unit and, thus, controls the amount of chlorine used proportionately with the flow rate.

All chlorination systems have a "contact tank" following the addition of the chlorine. The tank is usually shaped and baffled to promote complete mixing of the contents. This is necessary to provide contact between the chlorine and any bacteria present. The contact tank is sized to retain the sewage for 30 to 60 minutes to allow the chlorine time to react.

Disinfection is generally the final treatment process prior to discharge.

RECOMMENDED MAINTENANCE

1) Be sure tanks are kept completely free of mud, sand, gravel, rocks, boards, and other debris.

2) Check oil level in the blower before starting up.

3) Do not turn on the spray pump until the plant is completely filled and water running out of the discharge. (If a spray pump is provided.) The scum return pipe should be adjusted so that water will be about 3/8 to 1/2 inch deep in the notch. Adjust the air valve so that water falls about 2 inches down in the pipe.

Daily

1) Make a daily inspection of the plant.

2) Rake the bar screen and burn or bury the screened solids.

3) Look for a uniform discharge of air in aeration tanks. (A quiet area indicates a clogged nozzle. Close the air valve, lift the diffusion unit, and clean the nozzle.)

4) Hose down the plant to remove foam and untidiness.

5) Squeegee growth from tank walls.

6) Check and break up scum, if any, in the settling tank to insure proper return through the skimmer.

7) Keep the chlorine stock solution tank or tablet chlorinator filled when needed.

8) Observe final effluent for clarity.

9) All areas having foam build-up should be washed down with water spray.

Weekly

1) Alternate blowers.

2) Clean air filter.

3) Check blower belts; keep center vertical movement at 1/2 inch to 1 inch.

4) Check time setting on time clocks.

5) Scrape wall and hoppers of settling tank.

6) Clean trash and weeds from around plant and equipment.

Monthly

1) Open gear box, oil drip drain—add oil if no drip.

2) Lubricate blower bearings.

3) Check air filter and clean when necessary.

Semi-annually

1) Change oil in gear box.

2) Lubricate blower motors.

Annually

1) Wire-brush and paint all rusted metal.

Lubrication

1) Blower—Before starting blower, be sure to check to see if oil has been put in the gear housing.

2) Blower bearings—Renew grease as needed with best grade, high temperature ball bearing grease (not ordinary cup grease) about once a month.

Common Problems

1) Motors will not run:

- General power outage.
- Fuses blown—replace; reset circuit breaker.
- Motors overloaded—push reset button; check overload heaters if reset does not start motor.

2) Excessive foaming or liquid appears soapy in aeration compartment:

- Over aeration—reduce running time.
- Lack of solids (usually found only during the first few weeks of operation).
- Excessive use of detergents—eliminate them before they enter the plant.
- Spray with water hose to break up foam.

3) Liquid is black, caused by large amount of septic sewage or blower is not running long enough:

- Aerate until chocolate brown color returns.
- Find source of septic sewage and eliminate.
- Set time clock for adequate aeration time.
- Check V-belt drive.

It is important to check the appearance of the aeration tank contents. A satisfactorily operating plant will have a heavy concentration of chocolate brown sludge, with little or no foam and no objectionable odor in the aeration compartment. This sludge should settle readily so that the water in the upper part of the final settling compartment will be clear and free of solids, not cloudy or turbid. Should the aeration compartment contents be dark gray or black or have a septic sewage odor, an inadequate air supply would be the cause. With experience, the need for additional air can be accurately gauged by the appearance of the aeration tank liquid.

4) Sludge accumulation on top of settling tank:

- Airlift skimmer not returning.
- Sludge return airlifts not returning, or not returning enough. Check hoppers for sludge build up.
- Excessive amount of grease (check grease trap and clean, if necessary, or eliminate

before entering plant).
- Refer to "Sludge Problems" below.

5) Large quantities of solids going over effluent weir:
- Sludge airlifts not returning or not returning enough. Check air lines and air lift tube for blockage.
- Plant overload—check sewage flow and volume and have raw sewage analyzed for B.O.D. and suspended solids.

6) Heavy black sludge on bottom of settling tank:
- Scrape more often.
- Return more sludge by opening needle valve to increase flow to airlift.

7) Large amount of scum on surface (maybe due to clog in air line):
- If clogged, rod out line or blow out by shutting off discharge end and opening needle valve.
- Spray surface with water to break up foam and release gas formed bubbles.

SLUDGE PROBLEMS

During the first few weeks of a plant's operation, one of the most common problems is the accumulation of sludge on the hopper slopes of the settling tank. This problem may be almost completely eliminated by proper care and maintenance.

The purpose of the tank is to settle out and separate the solids that pass through from the aeration tank. Normally the liquid in the settling tank should be still to accomplish this purpose. However, one of the characteristics of sludge is that it is likely to be stringy and sticky during the early weeks of plant operation. As it settles toward the bottom of the tank, the hopper slopes are the most convenient place for the stringy, sticky masses of sludge to come to rest.

After a week or so the continuous build-up of sludge will finally become a spongy mass completely filling the lower half of the tank. This will stop the normal movement of sludge to the hopper bottom where it is picked up by a sludge return pipe that returns it to the aeration tank for retreatment. After a short time this spongy mass will form a gas and break up into chunks of sludge that float to the surface of the water. Here, if the condition persists, it will finally become a solid mass again growing deeper as the sludge builds up from the bottom. Naturally this solid sludge prevents the equipment in the settling tank from performing properly. The skimmer, the froth control pump, and the final discharge weir are all hampered in their operation. In addition, the sludge mass gives off a very strong stench.

Proper preventive maintenance is the best cure for sludge accumulation.

Every day during the first few weeks of operation, the operator or some responsible person should visit the plant to see that all equipment is running and to check the settling tank.

A small scraper is used to keep the hopper slopes free from sludge build-up. The hopper slopes begin about three to five feet below the water level. The operator should scrape all around the hopper with a slow, easy downward motion, just enough to help move the sludge toward the bottom of the hopper where it can be picked up by the sludge pump. Do not stir or agitate the sludge roughly or it will break up and rise to the water level. If this happens, the chunks must be dipped back into the aeration tank for further treatment.

This procedure should be followed faithfully until the plant bacteria begin to work properly. This is usually from three to five weeks, depending on the strength of the raw sewage coming into the plant. In almost every case, the above procedure will prevent sludge problems. After the plant begins to work, the procedure may be reduced to weekly or even monthly as the operator may determine from experience. (The amount of sludge being returned to the aeration tank may be seen by watching the discharge pipe or pipes that empty into the aeration chamber.)

In addition to sludge build-up, there are other associated conditions which need attention. It is possible for a sludge return pipe to be discharging clear water while there is three or four feet of sludge in the hopper. This occurs when soft sludge packs solid almost to the hopper bottom except for a narrow channel running down through the mass to the pump intake. Clear surface water is pulled down through this channel and up through the pump without disturbing the sludge mass. Therefore, visual checking of the sludge return discharge is not sufficient. It is necessary to gently move the mass downward to the pump intake.

Another common condition is a plugged sludge airlift. Sludge, being heavier than water, will normally settle to the hopper bottom. If the sludge pump is not returning at least "one third of a pipe full" into the aeration tank, the slower movement of sludge may allow the sludge to pack

in the one-foot square area at the hopper bottom and pump intake. Finally the sludge begins to build up inside the airlift tube until it is blocked completely. This may be remedied by shutting off the air supply to all other equipment and opening the air control valve to the blocked sludge pump. If blockage isn't moved, the three-inch valve should be turned off, causing the air to reverse its direction and back flush the pump. In the absence of a valve, the pipe plug must be removed and the discharge pipe closed at the tee with a shop rag or plumber's stopper to divert the air downward through the vertical pump tube. The great volume of air should break up the solid mass at the pump intake. The chunks that rise to the top must be dipped back into the aeration tank or broken up into small pieces to be returned by the skimmer.

When mud gets into a plant, the part that gets into the settling tank will naturally sink to the hopper bottoms. Here it mixes with the sludge and forms a heavier, more solid mass than sludge alone. The sludge return airlifts will not lift heavy mud. Mud should be removed as soon as it is discovered.

Remember: A clean, properly cared for plant means fewer repairs and maintenance and more efficient operation.

FLOW MONITORING

Flow monitoring includes measurement and sampling of the sewage. Flow measurement requires a primary control device, such as a weir or a flume that has a mathematical relationship between water depth and flow rate. The primary control device is shaped in such a way that by measuring the depth of water flowing through it, a flow rate can be readily determined from a chart or calculated from the formula. Each type and size of weir or flume has its own formula.

Samples of the sewage are taken before and after treatment to determine the efficiency of the treatment plant. All treatment plants that discharge to surface waters are required by the State to sample the effluent prior to discharge. Samples can be single or composite samples. A single sample taken at a specific time is representative of the sewage at the time of collection only. A composite sample consists of a series of single samples taken over a period of time and then combined in a single container. A composite sample represents the average condition of the sewage for the period over which it was collected. Composite sampling can be done on a timed basis, with samples taken at preset time intervals or it can be on a "flow proportionate" basis at preset volume intervals (such as every 1,000 gallons). Many types of meters and samplers are manufactured for use in sewage applications.

The primary control devices require little maintenance other than routine cleaning. Mechanical flow meters and samplers vary widely in complexity and may require the assistance of the manufacturer for repair.

ENVIRONMENTAL PROTECTION

State environmental protection laws typically require that each treatment plant have at least one operator who has direct charge of the operation and makes regular inspection of the plant. This person must have a Certificate of Competency.

In each state, the EPA or equivalent regulatory agency requires regular submissions of operation reports. In Illinois, application forms, operation report blanks and explanatory sheets may be obtained from:

Environmental Protection Agency
Division of Water Pollution Control
2200 Churchill Road
Springfield, Illinois 62706

23 / Electrical Systems

Maintenance of electrical systems and equipment is necessary for reasons of safety, energy, conservation, and equipment life.

The use of maintenance logs helps keep track of maintenance work. If the records are consistently updated, they can serve as a preventive maintenance tool in establishing trends and anticipating problems. A great deal of electrical energy can be conserved by performing proper maintenance on electrical equipment.

It should be noted that technology is having a great impact on school electrical systems in general and lighting in particular. Most schools, for example, either have upgraded their lighting or soon will to take advantage of new knowledge and new illumination systems and to eliminate the cost of excess lighting. At the same time, concern for the environment—both inside and outside the school—also is having an impact on school lighting systems. It seems likely, for example, that future legislation will restrict the use of some types of lamps. New knowledge about the effects of various amounts and types of lighting may influence lighting systems found in schools.

Lighting

Several types of lighting sources are used in school buildings today, in combination with appropriately designed fixtures. These are the fluorescent lamp, incandescent filament lamp, quartz halogen, metal halide, high-pressure sodium, and the mercury vapor lamp.

The fluorescent lamp is the principal interior light source for schools because it produces three times the light and has nine times the life of the same wattage incandescent lamp. Metal halide lamps have grown in use for gymnasiums and shops. High pressure sodium lamps are widely used for exterior lighting applications.

There are various color shades of fluorescent lamps, but the two most widely used are the "cool white" and the "warm white." The latter has more red in its spectrum and is more flattering to people and furnishings. When replacing lamps, match those being removed as to type of starting device and ballast, lamp terminals, and color shade.

If a lamp fails to light, the cause may be:

1) **Poor lampholder contact.** Twist gently in the socket. If the lamp flashes, look for a loose lead wire or lampholder part.

2) **Replace the starter** if the lamp is a preheat type.

3) **Burned out lamp.** Check the date installed to see if the lamp has burned its rated life. (Mark the date on all lamps when replacing them.) If the lamp has had a short life, check ballast, starter, and lamp purchase source.

4) **Faulty fixture.** Try the lamp in an operating fixture. If it is okay, check the original fixture for dirt, dust, and moisture accumulation. Also, look for worn lamp holder contacts or defective ballast. (Some ballasts have external fuses; check for blown fuses.)

5) If the lamp blinks or flashes it may indicate the end of lamp life, as indicated by darkened ends and reddish glow.

6) Lamps which are lit but have long horizontal dark streaks are usually in a cold air path,

Electrical Systems, original chapter by Charles R. Kuglin, of Childs and Smith, Inc., Lowell N. Peterson, of Beling Consultants, R.W. Bardach, of Peabody, Gordon-Piatt, Inc., and J.E. Ramshaw, of Brown, Davis, Mullins and Associates, Inc. Third Edition review and update by Glen L. Bellows, of Buchanan, Bellows and Associates, Ltd.

Cleaning Compounds for Light Fixtures

Here are some guidelines for cleaning and protecting the various surfaces found on fluorescent light fixtures:

1) **Aluminum:** Use mild soap and cleaners and thoroughly rinse with clean water immediately after cleaning. Do not use strong alkaline cleaners.

2) **Porcelain enamel:** Use non-abrasive cleaners. Detergents and most glass cleaners are satisfactory.

3) **Synthetic enamel:** Use mild cleaners. Do not allow the fixture to soak in solutions as it may soften. Do not use alcohol or abrasive cleaners. Detergents are satisfactory.

4) **Glass:** Same as porcelain enamel. Use dry cleaners on clear glass panels but not on etched or sand blasted surfaces. Detergents are satisfactory.

5) **Plastics:** Dust is attracted by a static charge developing on plastic. Cleaning once a year with a detergent will provide satisfactory relief from static dirt accumulations. Destaticizers are available which give a greater protection if desired. Do not wipe plastic dry. After rinsing allow to air dry.

such as from an air conditioning system. Deflect air away from the lamp and the condition will disappear.

Unless fixtures and lamps are properly maintained and kept clean, a large percentage of the illumination produced is wasted, causing an inefficient use of power. Proper maintenance of a lighting system, therefore, includes cleaning and washing fixtures and lamps as well as surrounding walls and ceilings. (See Procedure 9 in Chapter 9.) It also includes repair and replacement of defective components of the lighting system.

It is important to keep an adequate stock of replacement parts, including lamps, starters, ballasts, sockets and fixtures to match those in service.

CLEANING FIXTURES

With the trend to more complex lighting systems, the time and labor to clean these systems have increased. Fluorescent installations have more fixture area and lamp surface than their incandescent counterparts. The following steps are suggested for cleaning fluorescent fixtures:

1) Clean louvers with two people. The person on the floor receives louvers and cleans them with sponge and cleaning solution. The person on the ladder cleans fixture surfaces. Plastic louvers should be washed, rinsed, and drip dried. Do not wipe dry, as an electrostatic charge will form and speed dirt accumulation.

2) Clean lamps at floor level. Use a wash sponge and a separate rinse sponge. Make a downward stroke with the wash sponge in one hand followed by the rinse sponge in the other.

3) Make fixtures shock-free. Turn off the electrical circuit serving the fixtures.

4) Brush heavy dirt deposits off the top of the fixture and then wash with detergent.

5) Use a paint brush and detergent around sockets. Use a second brush and rinse water and allow to air dry. Use a wash and rinse sponge for the remainder of the reflector.

ENERGY CONSERVATION

Energy conservation can be realized on lighting systems whether in a new building, remodeling of existing areas, relamping of existing lighting fixtures and/or ballast replacement. By the use of low energy ballasts and lamps, various percentages can be saved, with a minor reduction in room lighting levels (foot-candles). It is important to check state laws for minimum lighting levels required in schools. Light levels for individual rooms should be logged annually and compared.

A log for keeping track of lamp and ballast replacements is provided in the Management Tools Appendix.

Service and Distribution Equipment

Electrical service and distribution equipment includes low voltage (600 volts and below) circuit breakers and fusible units, as well as high voltage (above 600 volts) switching units, feeder cables, transformers, and the like. This equipment should be operated, tested and cleaned once a year.

Most school electrical systems are protected by circuit breakers—either molded case breakers or air circuit breakers. Ground fault interrupter (GFI) outlets also are widely required in schools.

Circuit breakers in lighting panel boards usually are of the plug-in, molded-case, thermal-magnetic type. They compensate for ambient temperatures and will carry full National Electric Code loading (80 percent of rating) in room tem-

peratures as high as 120 degrees F.

When a short-circuit or overload trips a breaker, the operating handle assumes a position midway between "OFF" and "ON," identifying the circuit in trouble. When this occurs, check the circuit for the cause of the fault; then switch the handle to "ON" to restore the service.

Note: The maintenance manager needs to insure that electrical service maintenance is assigned to individuals who are properly trained or licensed for the specific task. The performance testing of circuit breakers, for example, is not a normal maintenance function and should be performed only by qualified, properly equipped personnel.

To maintain panel boards, check all connections once a year for tightness. Keep the interior of the enclosure dry and free of dust. If a unit fails, replace it; the cost is nominal. If breakers open for no apparent reason, check each circuit that terminates in the panel with an ammeter to be sure the load it is carrying does not exceed ratings of the NEC (National Electric Code).

MOLDED CASE BREAKERS

Molded-case breakers are sealed, reasonably tamper-proof units. In ratings up to 100 amperes, defective units are replaced rather than repaired. No extensive maintenance is possible without breaking the factory seal, which terminates the warranty and, in many types of breakers, voids the label of Underwriters Laboratories.

A qualified electrician should test all such breakers under load for calibration and positive operation at least once a year. Unless a breaker is operated occasionally, manually or electrically, it can become inoperable through disuse. If not electrically operated for extended periods, the internal mechanisms and linkage may become stiff and prevent the breaker from tripping even if three or four times the rates current is applied. Once operated, however, the breaker in most instances will be found to be serviceable.

Electrical testing under load will quickly indicate whether both the magnetic and thermal trip elements are functioning properly.

AIR-CIRCUIT BREAKERS

Checks twice yearly of this heavier switch gear are recommended. A special check should be made after each interruption of a heavy short-circuit current. If a breaker is kept in either an open or closed position for long periods, it should be opened and closed several times at periodic intervals to insure continuing and proper operation.

Caution: Before inspecting or adjusting any breaker, make sure that all service to the breaker is dead and that the breaker is completely disconnected from any bus or line. Check the grounding connection on the frame to be sure it is intact. Finally, temporarily ground all breaker studs and current-carrying parts during the inspection.

ANNUAL INSPECTION

1) Check contacts for cleanliness. Check arcing contacts and if pitted or burned, dress or replace. Do not attempt to repair laminated contacts that are badly burned or pitted; replace them.

2) Check terminal connectors for overheating. Make sure they are mechanically tight.

3) On mechanisms, check all nuts and bolts to be sure that they are in place and tight and that no pins or cotter pins have fallen out. Check all moving parts for binding. Operate breaker several times for functioning of all parts. Lubricate bearing points lightly.

4) Check to be sure that all parts of the tripping device and trip latch move freely and that the armature of the overcurrent trip device has sufficient travel to release the breaker latch.

5) Check the load current against the breaker rating.

6) Check the control switch and the closing relay for proper operation. Replace any burned-out indicating lamps.

7) Check the mechanical condition of the enclosure. Make sure the operating handle is not blocked in any way. Make sure the ground connection of the enclosure is mechanically intact.

8) Check the positive tripping of undervoltage devices. If equipped with a dashpot, make sure the dashpot is clean.

Fusible equipment is reasonably maintenance free as far as electrical protection is concerned, provided the proper type of fuse is being used in the various circuits. However, every switch has a mechanical operator, and it should be operated, cleaned, checked and lubricated annually to insure reliability.

High voltage switching equipment, high voltage cables and transformers should be tested only by qualified testing organizations and should be

done annually. The testing organizations will provide written reports, graphs, and logs on the condition of this equipment.

Infrared Test: Every five years, have a testing firm do an infrared survey of all electrical equipment to identify any hot spots, loose connections or other problems.

Caution should be noted on distribution systems utilizing aluminum conductors. Aluminum conductors terminated directly into the lugs of circuit breakers or fusible switches will loosen to various degrees. These cable terminations should be tightened annually or preferably changed to a bi-metal lug type with crimp sleeve or some other suitable type of termination.

These aluminum connections can cause extensive electrical failures and damage to equipment if not maintained.

Motors and Controls

Motors and control equipment should be thoroughly inspected and cleaned once a year.

Warning: Turn off power ahead of the starter before performing any of the following operations. Check incoming line terminals with a voltmeter to ascertain positively that the equipment is totally de-energized. Also, note that many magnetic starters have control voltages derived from sources separate from starter terminal voltages. It is imperative that both power sources be de-energized prior to inspection of the starter.

Inspect starters once each year or after any severe electrical fault. Look for any moisture or signs of previous wetness or dripping inside the starter. Condensation in conduits or dripping from outside sources is a common cause of starter failure.

If there is an appreciable accumulation of dust and dirt, clean out the starter by using a brush, vacuum cleaner, or clean lint-free rags. In order to avoid blowing dust into other equipment, do not use a blower or compressed air.

Carefully inspect all visible electrical points and terminals in the electrical wiring systems. Retighten them if there is any sign of overheating or looseness. If joints or terminations appear to be badly discolored, corroded or pitted, or show signs of having been subjected to high temperatures, the parts should be disassembled and replaced or cleaned.

Examine fuse clips in combination starters. If there is any sign of overheating or looseness, check the spring pressure and tightness of the clamps. Replace the fuse clips if the spring pressure compares unfavorably with that of other identical fuse clips. Be sure that the condition which caused the overheating has been corrected.

Check all devices for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear.

Clean off oil and sooty deposits. Replace contacts if appreciable material has burned away or if material is charred or pitted. (Contact erosion is the most common cause of starter failure.) When replacing contacts, also replace contact pressure springs.

Check thermal overloads and fuses (in combination starters) to make sure they have the proper ampere rating and interrupting rating. Never attempt to defeat the rejection mechanism which prevents the installation of the wrong type of fuse.

Motors used for driving mechanical systems, such as exhaust fans, air handling units, or pumps, consume a large part of a school's electrical energy. These systems should be turned off when the building is unoccupied. The installation of a simple time clock (24-hour with seven-day dial) on each of the systems would allow automatic shutdown during unoccupied periods. For example, a 10-horsepower air handling unit shut down from 5:00 p.m. to 7:00 a.m. would save 140 kilowatt hours a day.

Caution: Do not shutdown mechanical systems that would allow water in the building to freeze during unoccupied periods.

While doing annual maintenance on motor control equipment, comparing the operating current (amps) of the motor on the circuit with the readings taken in previous years and with the motor nameplate full load amps will provide a quick indication of motor operation. Operating amperages higher than previous years may indicate bad bearings, belt problems, or other malfunctions in the various types of mechanical systems.

A typical log for keeping track of motor control and motor maintenance is provided in the Management Tools Appendix. The following table (pages 210-211) lists troubles encountered with motor controls, their causes and remedies.

Magnetic Contactors and Starters

Trouble	Cause	Remedy
CONTACTS		
Contact chatter	1) Broken shading coil.	1) Replace magnet and armature.
	2) Poor contact in control circuit.	2) Replace the contact device or use holding circuit interlock (3 wire control).
	3) Low voltage.	3) Correct voltage condition. Check momentary voltage dip during starting.
Welding or freezing	1) Abnormal inrush of current.	1) Check for grounds, shorts, or excessive motor load current or use larger contactor.
	2)Rapid jogging.	2) Install larger device rated for jogging service.
	3) Insufficient tip pressure.	3) Replace contacts and springs, check contact carrier for deformation or damage.
	4) Low voltage preventing magnet from sealing.	4) Current voltage condition. Check momentary voltage dip during starting.
	5) Foreign matter preventing contacts from closing.	5) Clean contacts with alcohol. Contactors, starters, and control accessories used with very small current or low voltage should be cleaned with alcohol.
	6) Short circuit.	6) Remove short or fault and check to be sure fuse or breaker size is correct.
Short contact tip life or overheating of contact tips	1) Filing or dressing.	1) Do not file silver tips. Rough spots or discoloration will not harm tips or impair their efficiency.
	2) Interrupting excessively high currents.	2) Install larger device or check for grounds, shorts, or excessive motor current draw.
	3) Excessive jogging.	3) Install larger device rated for jogging.
	4) Weak tip pressure.	4) Replace contacts and springs, check contact carrier for deformation or damage.
	5) Dirt or foreign matter on contact surface.	5) Clean contacts with alcohol.
	6) Short circuits.	6) Remove short or fault and check to be sure fuse or breaker size is correct.
	7) Loose connection.	7) Clean and tighten.
	8) Sustained overload.	8) Check for excessive motor load current or install larger device.

Trouble	Cause	Remedy
COILS		
Open circuit	1) Mechanical damage.	1) Handle and store coils carefully.
Roasted coil	1) Over voltage or high ambient temperature.	1) Check application, circuit and current. Replace coil.
	2) Incorrect coil.	2) Install correct coil.
	3) Shorted turns caused by mechanical damage or corrosion.	3) Replace coil.
	4) Under voltage, failure of magnet to seal in.	4) Correct system voltage.
	5) Dirt or rust on pole faces increasing air gap.	5) Clean pole faces.
OVERLOAD RELAYS		
Tripping	1) Sustained overload.	1) Check for grounds, shorts, or excessive motor currents and correct cause.
	2) Loose connection on load wires.	2) Clean and tighten.
	3) Incorrect heater.	3) Heater should be replaced with correct size.
MAGNETIC AND MECHANICAL PARTS		
Noisy magnet	1) Broken shading coil.	1) Replace magnet and armature.
	2) Magnet faces not mating.	2) Replace magnet and armature.
	3) Dirt or rust on magnet faces.	3) Clean. Replace if rust is excessive.
	4) Low voltage.	4) Check system voltage and voltage dips during starting.
Failure to pick-up and seal	1) Low voltage.	1) Check system voltage and voltage dips during starting.
	2) Coil open or shorted.	2) Replace.
	3) Wrong coil.	3) Replace.
	4) Mechanical obstruction.	4) With power off check for free movement of contact and armature assembly.
Failure to drop-out	1) Gummy substance on pole faces.	1) Clean pole faces.
	2) Control circuit continues to be energized.	2) Check coil circuit.
	3) Worn or rusted parts causing binding.	3) Replace parts.
	4) Residual magnetism due to lack of air gap in magnet path.	4) Replace magnet and armature.

Fire Alarm Systems

A fire alarm system must be both electrically and mechanically secure. This means that all devices, as well as the operating power, must be supervised. The fire alarm system should be tested at least monthly by:

- Disconnecting a signal
- Disconnecting a station
- Disconnecting a detector
- Disconnecting the operating power

When any of these is done, the trouble bell must ring. Be certain to reestablish connections.

Signals can be tested by operating a test button or activating a station.

Heat detectors can be tested by putting a warm damp cloth around the detector for about one minute or by using a portable hair dryer. (DO NOT use a lighted match or other open flame.) Rate-of-rise detectors will actuate if the temperature is raised 15 degrees F. in one minute. Fixed-temperature detectors will operate only at the rated temperature; when the temperature reaches this point the solder melts and closes the electrical contacts. Hence, any test will require that the detector element be replaced.

Smoke detectors usually are made so that the dirtier they get the faster they will activate. This means that their screens must be cleaned at regular intervals, depending on the location, usually once or twice a year. Detectors of the radioactive type must be given a wipe test every three years after the date of installation.

On fire alarm systems of the annunciated type there should be a means of testing the lamps. On most annunciators there is a test button which lights all the lamps once, revealing any defective or burned out lamp.

Systems which are connected to municipal fire alarm systems should be disconnected during local tests, so that alarms do not go into the municipal system. However, with the assistance of the fire department, the connection to the municipal system should be checked regularly for reliability.

While testing for both circuit supervision and system operation (signals or alarm actuation device), different devices in various locations should be used each time.

An on-going log of tests will insure proper equipment and system operation. The log for each test should include the following information:

- Date of test.
- Supervision test: Devices disconnected (location and type).
- System operation test: Devices operated (location and type).
- Power supply supervision test: (normal or malfunction).

Section SIX

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Environmental Resources

Where to Obtain Environmental Information and Assistance

This listing of government agencies and other organizations dealing with environmental issues was compiled by William C. Bradley, of C & W Bradley, P.C., Rockford, IL., to accompany the environmental primer in Chapter 6. It is provided as an aid to school officials in need of specialized information or help. It is deemed accurate at the time of publication, but the passage of time is likely to see some changes in locations, telephone numbers and/or resources available.

This special appendix consists of the following sections:

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Telephone Numbers for Regional Offices of the U.S. Environmental Protection Agency

To help locate the appropriate office, states served are listed with each region.

Region 1—CT, ME, MA, NH, RI VT

General Number	(617)565-3420
External Affairs	(617)565-2713
Hazardous Waste Ombudsman	(617)573-5758
Small Business Ombudsman	(617)565-3617

Region 2—NJ, NY, PUERTO RICO, VIRGIN ISLANDS

General Number	(212)637-3000
External Affairs	(212)637-3662
Hazardous Waste Ombudsman	(212)637-4126

Region 3—DE, DC, MD, PA, VA, WV

General Number	(215)597-9800
External Affairs	(215)597-6938
Hazardous Waste Ombudsman	(215)597-9807

Region 4—AL, FL, GA, KY, MS, NC, SC, TN

General Number	(404)347-4727
External Affairs	(404)347-3004

Region 5—IL, IN, MI, MN, OH, WI

General Number	(312)353-2000
Public Affairs (in IL)	(312)353-2072
Hotline (within region IN, MI, MN, OH, WI)	(800)621-8431

Region 6—AR, LA NM, OK, TX

General Number	(214)655-6444
External Affairs	(214)655-2200
Hazardous Waste Ombudsman	(214)655-6701

Region 7—IA, KS, MO, NE

General Number	(913)551-7000
Public Affairs	(913)551-7003
Hazardous Waste Ombudsman	(913)551-7010

Region 8—CO, MT, ND, SD, UT, WY

General Number	(303)293-1603
External Affairs	(303)294-1107
Public Affairs Branch	(303)294-1120
Hazardous Waste Ombudsman	(303)294-1720
Small Business Ombudsman	(303)294-1111
Emergency Response	
Hotline (24 Hours)	(303)293-1788
Within Region	(800)227-8914

Region 9—AZ, CA, HI, NV, AMERICAN SAMOA, GUAM

General Number	(415)744-1305
External Affairs	(415)744-1015
Public Affairs	(415)744-1585
Hazardous Waste Ombudsman	(415)744-1730

Region 10—AK, ID, OR, WA

General Number	(206)553-2000
External Affairs	(206)553-1107
Hazardous Waste Ombudsman	(206)553-6695
Public Information Center	(206)553-1200
Within Region	(800)424-4EPA

Directory of Special Resources for Environmental Issues

This directory covers a wide range of environmental issues—from Air to Wetlands—organized in alphabetical order. Agencies and organizations that can provide specialized information or assistance are listed under each topic.

Air and Radiation

Air Risk Information Center Hotline
Air RISC
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards, MD 13
Or Environmental Criteria Assessment Office, MD 52
Research Triangle Park, NC 27711
(919) 541-0888

Air Pollution Emissions Hotline, Control Technology Center—CTC deals with air emissions and air pollution control technology for all air pollutants. Services are provided to state and local air pollution control agencies and EPA Regional Offices. Services to others may be limited or provided on a cost reimbursable basis.

U.S. Environmental Protection Agency
Emissions Standards Division
Office of Air Quality Planning and Standards, MD 13
Research Triangle Park, NC 27711
(919) 541-0800
(919) 541-0242 FAX

Asbestos Ombudsman Clearinghouse/Hotline—AHERA

U.S. Environmental Protection Agency
Asbestos Ombudsman, 1230C
401 M Street, SW
Washington, DC 20460
(800) 368-5888 Recorder/24 Hours
(703) 305-6462 FAX

Clean Lakes Clearinghouse—CLC is a resource center for information on lake and watershed restoration, protection and management.

Clean Lakes Clearinghouse
The Terrene Institute
1717 K Street, NW, Suite 801
Washington, DC 20006
(800) 726-LAKE
(202) 296-4071 FAX

Emergency Planning and Community, Right-to-Know Information Hotline—The EPA's Emergency Planning and Community Right-to-Know Information Hotline's primary function is to provide regulatory, information and policy decisions to federal agencies, state and local governments, the public, the regulated community and other interested parties in response to questions about the Emergency Planning and Community Right-to-Know Act (Title III of SARA). The Hotline provides information on the availability of documents related to Title III of SARA and provides copies of selected documents related to Title III of SARA on a limited basis.

Booz, Allen & Hamilton, Inc.
1725 Jefferson Davis Highway
Arlington, VA 22202
(800) 535-0202
(800) 553-7672 TDD
(703) 412-3333 FAX

Green Lights Program—The Green Lights Program provides information on energy efficient lighting and how companies can join or become an ally with the Green Lights Program. An EPA speaker travels around the United States encouraging companies to join.

The Bruce Company
1850 K. Street, NW, Suite 290
Washington, DC 20006
(202) 775-6650
(202) 775-6680 FAX

Hazardous Waste Ombudsman Program—This program is the most complex regulatory pro-

gram developed by the EPA. It assists the public and regulated community in resolving problems regarding any program or requirement under the Hazardous Waste Program. The Ombudsman Program, located in headquarters and each regional office, handles complaints from citizens and the regulated community, obtains facts, sorts information, and substantiates policy.

U.S. Environmental Protection Agency
Hazardous Waste Ombudsman Program, 5101
401 M Street, SW, Room SE 315
Washington, DC 20460
(202) 260-9361
(800) 262-7937
(202) 260-8929 FAX

Indoor Air Quality Information Clearinghouse

P O BOX 37133
Washington, DC 20013-7133
(202) 484-1307
(800) 438-4318
(202) 484-1510 FAX

Inspector General Hotline—Inspector General investigates fraud, waste or mismanagement in EPA-funded activities.

U.S. Environmental Protection Agency
Inspector General Hotline, 2410
Room 307 NE, 401 M Street, SW
Washington, DC 20460
(800) 424-4000
(202) 260-6976 FAX

Local Air Pollution Control Hotline—This clearinghouse enables state and local air pollution control agencies to exchange information and work toward more consistent emission levels.

Best Available Control Technology
Lowest Achievable Emission Rate Clearinghouse
Environmental Protection Agency
Research Triangle Park, NC 27711
(919) 541-5432

National Lead Information Center Hotline—Provides information to help parents protect their children from lead poisoning in the home; list of state and local contacts.

National Toll-Free Number: (800) LEAD-FYI
(800) 532-3394

TDD Number for
Hearing Impaired: (800) 526-5456

National Pesticide Information Retrieval System—NPIRS, a subscription database of the Center for Environmental and Regulatory Systems (CERIS), provides information (*for subscribers only*) on pesticide products (current and historical) which have been registered by the EPA. Registration support documents, commodity/tolerance data, Material Safety Data Sheets, fact sheets, and state product registration data are provided.

CERIS (NPIRS)
1231 Cumberland Avenue, Suite A
West LaFayette, IN 47906-1317
(317) 494-6614
(317) 494-9727 FAX

National Radon Hotline—Information on radon health effects and testing homes for radon. Radon information callers will receive a brochure and a coupon for a discount radon test kit.

National Safety Council
Environmental Health Center
Suite 401
1019 19TH Street, NW
Washington, DC 20036

National Radon Hotline
BOX 33435
Washington, DC 20035-0435
(800) SOS-RADON 24-Hour, Toll Free Hotline
(202) 293-0032 FAX

National Response Center for Spills—Deals with oil, hazardous chemical, biological or radiological releases. The National Response Center receives reports of oil, hazardous chemical, biological or radiological releases. The NRC then passes those reports to a pre-designated federal On-Scene Coordinator (OSC), who coordinates clean-up efforts, and other responsible federal agencies.

National Response Center
U.S. Coast Guard Headquarters
2100 Second Street, SW, Room 2611
Washington, DC 20593-0001
(202) 267-2675
(800) 424-8802
(202) 267-2181 FAX

National Small Flows Clearinghouse—Deals with small community wastewater treatment.

National Small Flows Clearinghouse
West Virginia University
P O BOX 6064
Morgantown, WV 26505-6064
304 293-4191
800 624-8301
304 293-3161 FAX

Office of Public Liaison EPA Activities Update Hotline—Hotline was established to keep constituencies apprised of meetings and anticipated briefings; to provide a way for those attending briefings a way to verify time, date and place; to provide information from time to time concerning the availability of recently released documents; and to give persons who wish to receive the Activities Update Newsletter an opportunity to leave their name, affiliation, address, phone/fax numbers to be placed on the update's mail list.

U.S. Environmental Protection Agency
Office of Public Liaison (1702)
401 M Street, SW
Washington, DC 20460
(202) 260-9001 FAX

Office of Water Resource Center—Provides documents and videotapes dealing with ground and drinking water, water quality criteria, and wastewater treatment.

Office of Water Resource Center
401 M Street, SW, 4100 (P)
Washington, DC 20460
(202) 260-7786
(202) 260-4383 FAX

Pollution Prevention Information Clearinghouse—Deals with pollution prevention, source reduction, and recycling.

U.S. Environmental Protection Agency, 3404
401 M. Street, SW
Washington, DC 20460
(202) 260-1023
(202) 260-0178 FAX

Risk Communication Hotline—The Risk Communication Hotline responds to questions from EPA program and regional offices, the academic/scientific community, and the general public. The Hotline provides information on EPA's Risk Communication Program, responds to questions on Risk Communication issues and literature, and makes referrals to other related agency services and sources of information. A small library is maintained with a bibliographic database, reports, articles, books, conference summaries, Risk Communication materials, and training materials. Available publications are mailed out upon request.

U.S. Environmental Protection Agency
Risk Communication Hotline, 2127
Room 425, West Tower
401 M Street, SW
Washington, DC 20460
(202) 260-5606
(202) 260-9757 FAX

Safe Drinking Water Hotline—The Safe Drinking Water Hotline assists both the regulated community (public water systems) and the public with their understanding of the regulations and programs developed in response to the Safe Drinking Water Act Amendments of 1986.

U.S. Environmental Protection Agency
Office of Ground Water and Drinking Water
4601 Resource Center
401 M Street, SW
Washington, DC 20460
(800) 426-4791 (HOTLINE)

Small Business Ombudsman Clearinghouse/Hotline—Deals with regulations and information relevant to small business and assistance to small business to enhance voluntary compliance.

U.S. Environmental Protection Agency
Small Business Ombudsman, 1230C
401 M Street, SW
Washington, DC 20460
(703) 305-5938
(800) 368-5888 (recorder 24 hours a day)
(703) 305-6462 FAX

Solid Waste Assistance Program

P O BOX 7219
8750 Georgia Avenue
Silver Springs, MD 20907
(800) 677-9424 HOTLINE
(301) 585-0297 FAX

Toxic Substances Control Act, Assistance Information Service—The TSCA Assistance Information Service provides information on TSCA regulations. Technical as well as general assistance is available.

U.S. Environmental Protection Agency
Environmental Assistance Division, 7408
401 M Street, SW
Washington, DC 20460
(202) 554-1404
(202) 554-5603 FAX

Underground Storage Tank Hotline—The Environmental Protection Agency's RCRA/SF/OUST Hotline's primary function is to provide assistance to the public and regulated community

and other interested parties in understanding EPA's regulations pursuant to RCRA, UST, CERCLA, and pollution prevention/waste minimization.

RCRA SF/OUST Hotline
1725 Jefferson Davis Highway
Arlington, VA 22202
(703) 412-9810
(800) 424-9346
(800) 553-7672 TDD
(703) 412-3333 FAX

Wetlands Protection Hotline—The Hotline acts as a central point of contact for the Wetlands Division of the Office of Wetlands, Oceans and Watersheds to provide a wide range of information on wetlands protection efforts involving EPA and other organizations.

Labat-Anderson Incorporated
2200 Clarendon Boulevard, Suite 900
Arlington, VA 22201
(800) 832-7828

Libraries and Other Reference Sources

Extensive information is available on virtually any environmental topic from the following Illinois institutions and agencies.

Illinois Department of Energy
and Natural Resources Library
325 West Adams, Room 300
Springfield, IL 62704-1892
(217)785-2389
(217)785-2618 FAX

The Illinois Department of Energy and Natural Resources is a non-regulatory agency. The library collection includes volumes and periodical subscriptions, videotapes and some microfiche on the subjects of environmental and energy policy, waste management, siting, energy conservation, energy economics, and environmental impact statement and study.

Illinois Environmental Protection Agency Library
2200 Churchill Road (P. O. BOX 19276)
Springfield, IL 62794-9276
(217)782-9691
(217)524-4916 FAX

The collection contains books in paper copy, reports on microfiche, and journal subscriptions on the following topics:

Air Pollution
Aquatic Toxicology
Asbestos
Drinking Water
Environmental Law
Hazardous Waste
Health Effects of Pollutants
Water Pollution

Illinois Hazardous Waste Research
and Information Center
One East Hazelwood Drive
Champaign, IL 61820
(217) 333-8957
(217) 333-8944 FAX

The collection contains print and audiovisual materials related to hazardous waste with emphasis on waste reduction/pollution prevention. Includes monographs and serials.

Illinois Pollution Control Board
Scientific/Technical Section Library
State of Illinois Center, Suite 11-500
100 West Randolph Street
Chicago, IL 60601
(312)814-3620 (EXT. LIBRARY)
(312)814-3669 FAX

The collection includes materials in multi-media on air, water and land issues, and a limited collection of books and tapes. The library does not lend to individuals outside the agency. Please call before visiting the library.

University of Illinois at Urbana-Champaign
Engineering Library/Main Library
221 Engineering Hall
1308 West Green
Urbana, IL 61801
(217)333-3576
(217)244-7764 FAX

Comprehensive collection of books, periodicals, reports, microfiche, microfilms and CD/ROMS on environmental areas, considered one of the largest libraries in the world.

Recommended Publications on Environmental Issues

U.S. Government Printing Office (GPO)—The GPO is the publications production or procurement arm for Congress and the agencies of the federal government. GPO also disseminates information to the public through the Superintendent of Documents publications, sales and depository library programs. Established as the official printer of the nation, GPO is part of the legislative branch of the government.

U. S. Government Printing Office
710 North Capitol Street, NW
Washington, DC 20401

Office of Public Affairs
(202)512-1991

A Catalog of Hazardous and Solid Waste Publications—Request EPA Document Number EPA/530-B-92-001. Generated by the Office of Solid Waste, this is a list of publications frequently requested and the sources from which they are available. Includes abstracts, subject index, and lists by OSW document numbers, NTIS Stock Number and GPO number.

Office of Solid Waste
Communications, Analysis and Budget Division
U.S. Environmental Protection Agency
Resource Conservation and Recovery Act (RCRA)
Docket Information Center
401 M Street, SW
Washington, DC 20460
(800)424-9346 (RCRA/SF Hotline)
(703)412-9810 (in DC metro area)

Environmental Information Management: A State Resource Guide—Request Document Number EPA/220-R-92-001. This state resource guide is a quick reference to some of the many sources of environmental data and environmental information assistance programs and services that are currently available to states. The State Resource Guide facilitates identification of potential sources of environmental information and assistance that can help states attain their environmental protection goals.

Office of Information Resources Management
Information Management and Resources Division
U.S. Environmental Protection Agency
State/EPA Data Management Program, 3404
401 M Street, SW
Washington, DC 20460
(202) 260-3540
(202) 260-3923 FAX

EPA Headquarters Telephone Directory—Request Document Number EPA/208-B-92-003.

Office of Administration and Resources Management
National Data Processing Center

Superintendent of Documents
U.S. Government Printing Office
710 North Capitol Street, NW
Washington, DC 20402-9325
(202)783-3238
(202)512-2233 FAX

EPA Journal—Request Document Number 175-N SERIES. The EPA Journal is a bi-monthly magazine on environmental topics, usually theme-oriented.

Office of Communications,
Education and Public Affairs, 1701
U.S. Environmental Protection Agency
401 M Street, SW
Washington, DC 20460
(202)260-2133
(202)252-0231 FAX

Freedom of Information Act—Request Document Number FOIA MANUAL 1550. The Freedom of Information Act allows the public to gain access to its government's information. A FOIA request is a written request for records held or believed to be held by the environmental protection agency.

Office of the Administrator
Executive Secretariat,
Freedom of Information
U.S. Environmental Protection Agency
Freedom of Information Office, 1105
401 M Street, SW
Washington, DC 20460
(202)260-4048
(202)260-0295 FAX

Land Use and Land Cover Maps—Land Use Maps and Land Cover Maps are available for most of the United States. Land Use Maps refer

to human uses of the land (housing and industry) and Land Cover Maps describe the vegetation, water, natural surface and construction of the land surface. The scale used ranges from 1:100,000 for a few maps in the Western States to 1:250,000 for most other maps.

Distribution Branch
U.S. Geological Survey
Building 810
Denver Federal Center, Box 25286
Denver, CO 80225

Technical Assistance Directory—The programs, areas of expertise and primary contacts in each of the major offices of research and development operations are covered in this directory. The information is provided to improve communication and technology transfer. Request the following Document Number depending upon topic of interest:

Ensuring Safe Drinking Water	EPA/600-M-91/012
Mining Waste Management	EPA/600-M-91/027
Pesticide Waste Disposal	EPA/600-M-91/028
Air Quality Management	EPA/600-M-91/029
Solid Waste Disposal	EPA/600-M-91/030
Hazardous Waste Management	EPA/600-M-91/031
Small Community Waste Water Systems	EPA/600-M-91/032
Water Quality	EPA/600-M-91/033
Risk Assessment	EPA/600-M-91/034
Pesticide Usage Guidelines	EPA/600-M-91/035
Pollution Prevention	EPA/600-M-91/036
Environmental Impact Assessments	EPA/600-M-91/037
EPA Information Sources	EPA/600-M-91/038
Environmental Management	EPA/600-M-91/039
Directory Of EPA TIPS Locations	IMSP/220-B-92-023

Office of Research and Development
U.S. Environmental Protection Agency
Center for Environmental
Research Information (CERI)
ORD Publications Unit
Cincinnati, OH 45268
(513)569-7562
(513)569-7566 FAX

or

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
(703)487-4650
(703)321-8547 FAX
Rush Service: (800) 553-NTIS

Quick Reference to Illinois Environmental Resources

School maintenance managers should be aware of state agencies that enforce environmental regulations or provide technical assistance. Each manager should compile a state-level directory for the appropriate state. Here is a quick reference list for school districts in Illinois.

Illinois Emergency Management Agency
(Reporting a leaking UST) (800) 782-7860

Illinois Department of Energy and Natural Resources
(Conservation) (217) 782-2605

Illinois Department of Labor (217) 782-9386 or
(Right-To-Know Information) (217) 782-4102 or
(312) 793-2800

Illinois Department of Labor
(Toxic Substances) (312) 793-2800

Illinois Department of Nuclear Safety
(Radon) (217) 786-7127 or
(708) 790-5349

Illinois Department of Public Health
(Asbestos) (217) 782-3517
(Lead Information) (800) 545-2200 or
(217) 782-0403
(Plumbing Inspector) (217) 524-0799

Illinois Department of Transportation
(Hazardous Waste Hauling) (217) 785-3064

Illinois Environmental Protection Agency
(Asbestos) (217) 782-3397 or 7326
(Land Pollution Control) (217) 782-6760
(Lead in Water) (217) 785-8604
(Oil or Hazardous Material Emergency) (800) 782-7860

National Lead Information Center (800) 424-5323

Illinois Office of the State Fire Marshal (217) 785-5878 or
(Underground Storage Tanks) (217) 785-1020

U.S. Environmental Protection Agency
General Number - Chicago (312) 353-2000
ASHARA Information - Chicago
(Asbestos) (312) 886-6003
Region 5 Safe Drinking Water Branch
(Lead in Water) (312) 353-2151

WORK SHEET—DETERMINING FREQUENCIES FOR CLEANING AND SERVICES

Use the legend below to indicate how often each task must be performed in each area of the school.

AREAS / TASKS	Automatic Power Scrubbing	Chemical or Acid Spills	Chalkboard Cleaning	Dispenser Servicing	Dry Mopping	Dusting	Graffiti Removal	Interior Glass Cleaning	Light Fixture Cleaning	Plumbing Fixture Cleaning	Wall Washing	Wet Mopping	Waste Removal	Waxing Furniture	Soft Floor Refinishing	Hard Floor Refinishing	Carpet Vacuuming	Carpet Periodic Care	Exterior Window Washing	Sweeping
Cafeteria																				
Classrooms																				
Corridors																				
Entrances																				
Gymnasiums																				
Laboratories																				
Library, Music Room																				
Locker/Shower Rooms																				
Offices																				
Restrooms																				
Shops																				
Stairways																				
Swimming Pool																				

5W—Five times a week
4W—Four times a week
3W—Three times a week
2W—Twice a week
1W—Once a week

3M—Three times a month
2M—Twice a month
Q—Quarterly
SA—Semi-Annually
A—Annually

A3—Every three years
A5—Every five years
AN—As needed
AU—After every use
VP—During vacation periods

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CUSTODIAL AREA ASSIGNMENT

TO: _____ _____ _____
Building Time Allotted

General Description of area to be serviced:

_____

_____

It is intended that each written assignment and the periodic cleaning schedule provide a full eight hours of work. If this assigned area fails to include enough work to keep busy, contact the person in charge immediately and the situation will be corrected. Periodic cleaning such as waxing furniture is not covered in this written assignment, but it is the responsibility of the custodian to see that all periodic cleaning is accomplished.

The assignment details the work and, under normal conditions, the time the work is to be performed. Supervision may find it necessary from time to time to adjust the assignment. If there are any questions, please discuss them with the person in charge.

As members of the custodial team, each individual is expected to do the best job he or she can. Your job will be easier when you enjoy and receive satisfaction from your work and have a friendly feeling for the people you meet and work with.

Supplies and equipment are in Rooms _____, _____, _____, _____, _____, _____.

TASKS OR COMBINATION OF TASKS	HOURS From	To
1. _____		
2. _____		
3. _____		
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

Miscellaneous:

a. Perform periodic cleaning.
b. Keep custodial areas, equipment and supplies neat, clean and orderly.
c. Remove ice and snow from entrances.
d. Report repairs needed.
e. Clean bulletin board glass and all inside glass in your area excluding exterior windows.
f. Turn out all unnecessary lights.

Date _____ Approved _____

CUSTODIAL INSPECTION REPORT

FLOOR MAINTENANCE

Date _____

Crew Inspected

_____ Name _____ Name _____ Name

Building _____ Location No. _____ Areas Inspected _____

Floor Type _____ Floor Condition: ❑ Good ❑ Fair ❑ Poor

Condition of Finish: ❑ Good ❑ Fair ❑ Poor ❑ Bad

I. Procedure Used

Dust mopping . . . . . ❑
Dry cleaning . . . . . ❑
Cleaning w/finish . . . . . ❑
Renovating . . . . . ❑
Water mopping . . . . . ❑
Machine scrub . . . . . ❑
Auto scrub . . . . . ❑
Water pick-up . . . . . ❑
Mop & bucket . . . . . ❑
Water vac . . . . . ❑
Rinsing . . . . . ❑
Seal: 1 coat . . . . . ❑
2 coats . . . . . ❑
3 coats . . . . . ❑
Brand _____
Finish: 1 coat . . . . . ❑
2 coats . . . . . ❑
3 coats . . . . . ❑
Brand _____
Cleaner Used:
Brand _____

II. Equipment

	Condition		
	Clean		Needs Replacement
Dry mops	❑	❑	❑
Wet mops	❑	❑	❑
Mop units	❑	❑	❑
Floor machine	❑	❑	❑
_____	❑	❑	❑

III. Work Evaluation 1—Unsatisfactory 2—Marginal 3—Average 4—Above average 5—Outstanding

Quality of Finished Floor — 1—2—3—4—5

Streaking	❑ Yes	❑ No
Caused by	❑ Products	❑ Procedures
Splash marks	❑ Yes	❑ No
Lap marks	❑ Yes	❑ No
Clean baseboards	❑ Yes	❑ No
Void spots	❑ Yes	❑ No
Build-up	❑ Yes	❑ No
Powdering	❑ Yes	❑ No

IV. Personnel Evaluation — Evaluate each crew member anually on the "Work Appraisal" Form.

V. Verbal Summary _____

_____

_____

_____
Inspector

I Approve - Disapprove This Evaluation _____
Supervisor

CUSTODIAL INSPECTION REPORT

WINDOW MAINTENANCE

_____
Date

I. Crew Inspected _____ _____ _____ _____
Name Name Name Name

_____ _____ _____ _____
Name Name Name Name

II. Building _____ _____ Loc. No. _____ Areas Insp. _____

A. Window Washing (Condition of Windows: Heavy soil ❑ Avg. soil ❑ Light soil ❑)

1. Procedure Used
- Belts ❑
- Window pole ❑
- _____ ❑
- _____ ❑

2. Equipment
- Buckets ❑
- Sponges ❑
- Cheesecloth ❑
- Squeegee ❑
- _____ ❑
- _____ ❑

3. Supplies
Cleaner used:
- _____ ❑
- _____ ❑
- _____ ❑
- _____ ❑
- _____ ❑

4. Condition of Supplies and Equipment

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Equipment	❑	❑	❑	❑	❑
Supplies	❑	❑	❑	❑	❑
Belts	❑	❑	❑	❑	❑
Ladders	❑	❑	❑	❑	❑

B. Dusting (Condition of Venetian Blind: Heavy soil ❑ Avg. soil ❑ Light soil ❑)

1. Procedure Used
- Vacuuming ❑
- Washing ❑
- _____ ❑

2. Equipment
- Back vac. ❑
- Vacuum ❑
- Duster ❑

3. Supplies
- _____ ❑
- _____ ❑
- _____ ❑

4. Condition of Supplies and Equipment

	Adequate	Inadequate	Dirty	Clean	Needs Replacement
Vacuum	❑	❑	❑	❑	❑
_____	❑	❑	❑	❑	❑
_____	❑	❑	❑	❑	❑

III. Work Evaluation (1—Unsatisfactory, 2—Marginal, 3—Average, 4—Above Average, 5—Outstanding)

1. Quality of Finished Work 1 - 2 - 3 - 4 - 5 (Circle one)

Streaky windows	❑ Yes	❑ No
Blind dusting	❑ Adequate	❑ Inadequate
_____	❑ Accidents	❑ No Accidents

2. Individual Evaluation—Evaluate each crew member annually on the "Work Appraisal" Form.

IV. Verbal Summary: _____

_____

_____

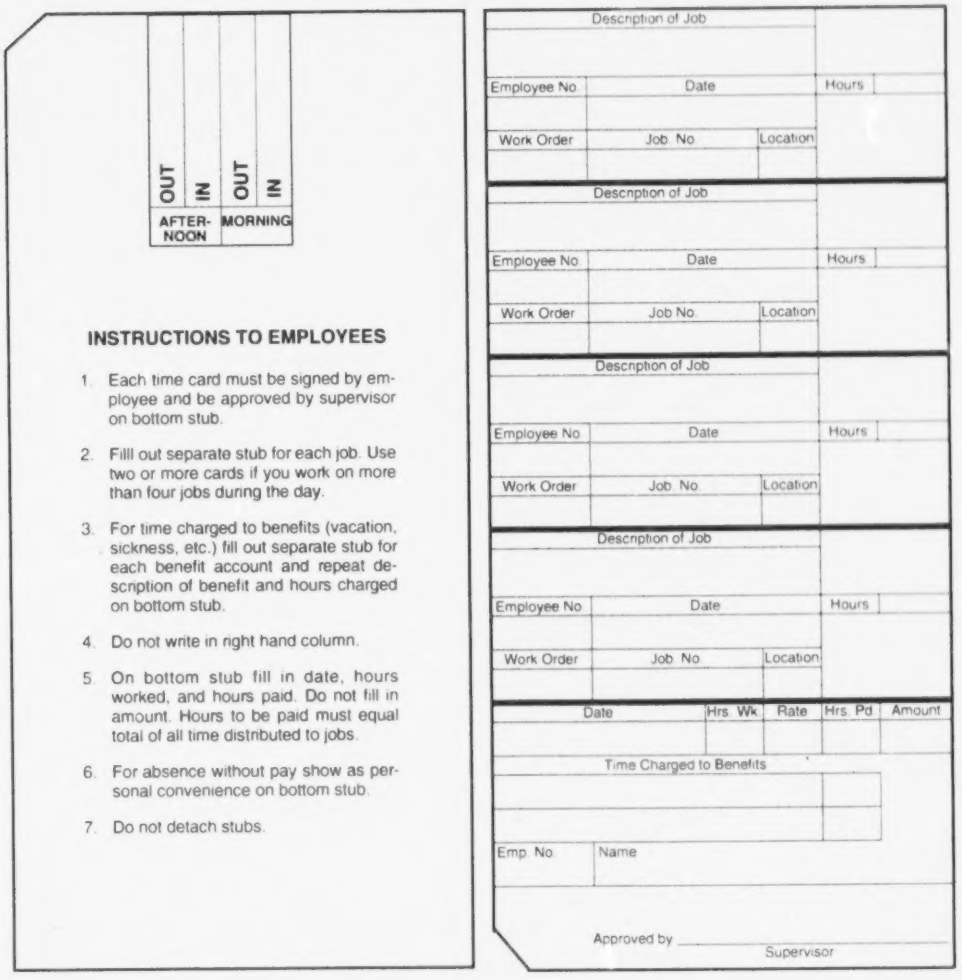
_____

_____

_____
Inspector

I Approve - Disapprove This Evaluation _____
Supervisor

TIME REPORT (FRONT & BACK)



OUT	IN	OUT	IN
AFTER-NOON		MORNING	

INSTRUCTIONS TO EMPLOYEES

1. Each time card must be signed by employee and be approved by supervisor on bottom stub.
2. FillI out separate stub for each job. Use two or more cards if you work on more than four jobs during the day.
3. For time charged to benefits (vacation, sickness, etc.) fill out separate stub for each benefit account and repeat description of benefit and hours charged on bottom stub.
4. Do not write in right hand column.
5. On bottom stub fill in date, hours worked, and hours paid. Do not fill in amount. Hours to be paid must equal total of all time distributed to jobs.
6. For absence without pay show as personal convenience on bottom stub.
7. Do not detach stubs.

Description of Job

Employee No.	Date	Hours
Work Order	Job. No.	Location

Description of Job

Employee No.	Date	Hours
Work Order	Job. No.	Location

Description of Job

Employee No.	Date	Hours
Work Order	Job. No.	Location

Description of Job

Employee No.	Date	Hours
Work Order	Job. No.	Location

Date	Hrs. Wk.	Rate	Hrs. Pd.	Amount

Time Charged to Benefits

Emp. No.	Name

Approved by _____
Supervisor

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CUSTODIAL AREA SANITATION REPORT

Building _____

_____ Custodian Date _____ 19____

KEY

DI—Dirty
DU—Dusty
S—Smeared or Stained
L—Littered
WX—Needs Wax
CW—Cobwebs
O—Organization
R—Repair needed
WA—Needs Washing
SV—Service Needed
✔—Satisfactory

Item	Room No. or Area					Item	Room No. or Area				
Mirrors						Door Glass					
Shelves						Transoms					
Soap Dispensers						Chalk Boards					
Sinks						Chalk Trays					
Towel Cabinets						Erasers					
Supplies						Tables					
Sanitary Cabinets						Book Cases					
Urinals						Desks					
Toilet Bowls						Desk Lamps					
Toilet Paper						Telephones					
Tile/Marble						Chairs					
Furniture						File Cabinets					
Equipment						Steps/Stairs					
Metal Partitions						Handrails					
Waste Cans						Drinking Fountains					
Floors						Bulletin Boards					
Radiators						Pipes/Ducts					
Window Ledges											
Woodtrim											
Baseboards											
Rest Room Doors											

Use reverse side for any additional comments.

This Report Has Been Discussed With Me.

_____
Custodian's Signature

Area Sanitation Report *continued*

Building

Custodian

PROBATIONARY ❑

CERTIFIED ❑

ADDITIONAL COMMENTS:

UNACCEPTABLE ❑ BELOW AVERAGE ❑ AVERAGE ❑ ABOVE AVERAGE ❑ OUTSTANDING ❑

COMMENTS FROM CUSTODIAN:

❑ Annual

❑ Special

❑ **Probationary**

❑ 1st mo. ❑ 2nd mo. ❑ 3rd mo.

❑ 4th mo. ❑ Special ❑ Special

WORK APPRAISAL FOR

Name _____

Classification _____

Period from _____ to _____

I. Performance Appraisal (rate each item by selecting the phrase most closely describing the employees actual work performance).

1. **Job Knowledge**

a. Area work
_____ Needs more training and experience
_____ Able to perform most of the work
_____ Knows enough to get by
_____ Able to perform all work well
_____ Able to perform most of the routine work
_____ No experience in past year

b. Floor work
_____ Able to perform most of the routine work
_____ Needs more training and experience
_____ Able to perform all work well
_____ Able to perform most of the work
_____ Knows enough to get by
_____ No experience in past year

c. Public function setups
_____ Able to perform all work well
_____ Able to perform most of the routine work
_____ Able to perform most of the work
_____ Needs more training and experience
_____ Knows enough to get by
_____ No experience in past year

d. Window washing
_____ Knows enough to get by
_____ Able to perform all work well
_____ Needs more training and experience
_____ Able to perform most of the work
_____ Able to perform most of the routine work
_____ No experience in past year

2. **Ability to Improve**
_____ Has mastered all duties of the position and still has the capacity to do more
_____ Unable to do most of the routine work
_____ Lacks ability to perform the work required by this position
_____ Has mastered most of the duties and still has the capacity to do more
_____ The routine work is the best that can be done and it causes trouble sometimes
_____ _____

3. **Quantity of Work**
_____ Has difficulty in organizing time in order to produce acceptable quantity of work. Has to be told what to do most of the time
_____ Self-starter—makes above average use of work time
_____ Needs prodding or work time will be unproductive
_____ Makes average use of work time and achieves average quantity of work
_____ Self-starter—makes outstanding use of work time
_____ _____
_____ _____

4. **Quality of Work**
_____ Work is outstanding, rarely find items that need improvement
_____ Work is above average, rarely find examples that have been skipped or neglected
_____ Quality of daily and periodic work is average
_____ Weekly checks are necessary
_____ Daily checks are necessary
_____ _____
_____ _____

5. **Attitude Toward Work**
_____ Appreciates help and criticism
_____ Downgrades the school and many of the employees
_____ Does what is expected
_____ Respects the school and his position in organization
_____ Just another job—makes caustic remarks
_____ _____
_____ _____

6. **Initiative**
_____ Little evidence of initiative noticed during working hours
_____ Develops solutions to problems
_____ No indication of initiative during working hours
_____ Develops workable solutions to most problems on his own but keeps supervision informed
_____ Relies on others but follows suggestions
_____ _____

7. **Loyalty**
_____ Critical of the school
_____ Willing to talk about the school in a positive way
_____ Inclined to be one-sided and negative about the school
_____ Self-starter, always willing to explain the school in a positive way
_____ If others insist, he will talk about the school in positive terms
_____ _____

8. **Personality**
_____ Talker but seems to get along with others
_____ Quiet but gets along with others
_____ Gets along with others
_____ Creates some feelings against self
_____ Respected by others
_____ _____

Work Appraisal *continued*

9. **Dependability**
   - _____ Average in work production and average attendance record
   - _____ Above average in work production with a perfect attendance record
   - _____ Average in work production with an unexplained attendance record average of one day sick every two months
   - _____ Barely average in work production with an above average attendance record
   - _____ Above average in work production with an above average attendance record
   - _____ _____
   - _____ _____

10. **Accident Prevention**
   - _____ Talks a lot about safety but doesn't do much about it
   - _____ Takes chances
   - _____ Works safely most of the time
   - _____ Sets a good example in safe work habits and encourages others to do the same
   - _____ Doesn't take chances but shows little interest in accident prevention
   - _____ _____
   - _____ _____

11. **Physical Makeup**
   - _____ Complains that work is too hard and the job is too large
   - _____ Accomplishes work with energy to spare
   - _____ Accomplishes work
   - _____ Appears tired most of the time
   - _____ Accomplishes work easily
   - _____ _____
   - _____ _____

12. **Cooperation**
   - _____ Is argumentative
   - _____ Aways does what is asked
   - _____ Seldom voices objections
   - _____ Always does a little more than is asked
   - _____ _____
   - _____ _____

II. General Comments

Health _____

Attendance _____

Progress _____

Suggestions for self-improvement or development _____

_____

Other comments _____

_____

_____ _____

(Date) Signature of person making work appraisal

III. Comments or suggestions by shift supervisor _____

_____

_____

_____

IV. Comments or suggestions by other members of office supervision _____

_____

_____

_____

This work appraisal has been discussed with me

_____ _____

(Signature of employee) (Date)

_____

(Signature of person explaining work appraisal)

DAILY WORK REPORTS

DAILY PERIODIC AREA CLEANING REPORT

Building _____ Loc. No. _____ Date _____

Custodian _____ Hours _____

Area — Use

L—Lab
O—Office
C—Classroom
R—Restroom
H—Hallway

Type of Cleaning

PD—Periodic dusting
CW—Clean-Wax
G—Glass
X—_____
O—_____
XX—_____

Room Number or Area Description	Area Use	Type of Cleaning	Number of Items of Furniture							Other Information
			Chairs	Desks	Tables	Files	Bookcases			

DAY
NIGHT

FLOOR MAINTENANCE DAILY WORK REPORT

Building _____ Loc. No. _____ Date _____

Name _____ Hrs. _____ Name _____ Hrs. _____

Name _____ Hrs. _____ Name _____ Hrs. _____

Total Hours _____

AREA - USE

L—Lab
O—Office
C—Classroom
R—Restroom
H—Hallway

PROCEDURE

C—Clean
W—2 Coats Wax
SS—Safe-T-San
T—Terrazzine
D—Dura Seal
R—Renovate
N—Numastic
S—Strip
F—2 Coats Fin.
SE—Seal

Room No. or Area Description	Area Use	Floor Type	Procedure Used	Sq. Ft.*	Other Info.

*Office Use Only

DAILY WORK REPORTS *continued*

Day _____
E. Night _____
D. Night _____

CARPET AND UPHOLSTERY WORK REPORT

Building _____ Loc. No. _____ Date _____

Name _____ Hrs. _____ Name _____ Hrs. _____

Name _____ Hrs. _____ Name _____ Hrs. _____

Total Hours _____

AREA - USE

L—Lab
O—Office
C—Classroom
H—Hallway
ST—Stairs
R—Reception
E—Entrance
_____Other

PROCEDURE

PL—Pile Lift
SP—Spot Clean
DF—Dry Foam Shampoo
AS—Anti-Static Treatment
OC—Odor Control (Vomit, etc.)

Room No. or Area Description	Area Use	Carpet Type	Carpet Color	Procedures Used	Amount and Type of Cleaning Materials	Square Footage

COMMENTS _____

WINDOW WASHING DAILY WORK REPORT

Building _____ Loc. No. _____ Date _____

No. of Workers _____ Total Hours _____

Total Hours to Remove Blinds..... _____
Total Hours to Clean Blinds..... _____
Total Hours to Install Blinds ..... _____
Total Hours to Dust Blinds..... _____
Total Hours to Clean Windows ..... _____
❑ Outside and inside
❑ Inside only
Total Hours to Clean Screens ..... _____

Area Desc. or Room No.	Venetian Blinds				Glass Washed			Other Info.
	Removed	Washed	Installed	Dusted	Window	Storm Windows	Screens	

MISCELLANEOUS FORMS

CUSTODIAL SUPPLY ORDER

Bldg. _____ Loc. _____ Date _____

Please fill in neartly and leave for person in charge to complete and turn in.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Signature

Location _____

REPAIR NEEDED

Building	Room No.	Date

Work as follows:

_____

_____

_____

_____

_____

Reported by _____

BITUMINOUS PAVING INSPECTION RECORD

Date of Report _____

Location	Total Surface Area	Sq.Ft. Needing Repair	Repair Description and Recommendation	Sq.Ft. Preventive Maintenance	Preventive Maintenance Recommended	Priority 1	Priority 2	Priority 3	Budget	Remarks

BURNER INFORMATION RECORD

MAKE _____ Model _____ SERIAL # _____

GAS BURNER

CO_2

High Fire _____

Low Fire _____

CO

High Fire _____

Low Fire _____

Net Stack Temperature

High Fire _____

Low Fire _____

Gas Burning Rate

High Fire _____

Low Fire _____

Gas Pressure at Orifices

High Fire _____

Low Fire _____

Gas Pressure Upstream of all Valves

High Fire _____

Low Fire _____

OIL BURNER, Grade _____

CO_2

High Fire _____

Low Fire _____

Smoke Bachrach Scale

High Fire _____

Low Fire _____

Nozzle Pressure

High Fire _____

Low Fire _____

Oil Burning Rate

High Fire _____

Low Fire _____

Net Stack Temperature

High Fire _____

Low Fire _____

Maintenance Checklist for

ROOFTOP AIR CONDITIONING

Date _____

Unit Model _____

Unit Serial _____

(X) Indicates when checks are made
(/) Indicates service performed

MAINTENANCE CHECKS	Weekly	Monthly	Yearly	Comments and Readings
I. ROOM THERMOSTATS				
A. Check to make sure they respond properly	X			
II. SUPPLY FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		
III. RETURN FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		
IV. CONDENSER FANS				
A. Listen for bearing noise	X			
B. Grease bearings			X	
C. Check fan belt tension		X		
D. Replace fan belts			X	
E. Check fan sheaves			X	
F. Check for debris in fan inlet		X		

ROOFTOP AIR CONDITIONING CHECKLIST *continued*

MAINTENANCE CHECKS	Weekly	Monthly	Yearly	Comments and Readings
V. COOLING COIL				
A. Check filters and replace as required	X	X		
B. Clean coil			X	
C. Refrigerant sight glass clear	X			
D. Drain in pan free		X		
VI. CONDENSER COIL				
A. Fan guards in place	X			
B. Clean coil		X		
C. Check and repair fins		X		
VII. REFRIGERANT COMPRESSOR				
A. Check oil level in sight glass	X			
B. Suction line cool to touch	X			
C. Check for short cycling	X			
D. Check for obvious leaks		X		
E. Check control panel wiring and contactors		X		
F. Install refrigerant gauges and check the following:				
1. Suction pressure			X	
2. Discharge pressure			X	
3. Voltage			X	
4. Amperage			X	
VIII. HEATING SECTION				
A. Check flue vents			X	
B. Check burner compartment for flame leakage	X			
C. Listen to burner light off	X			
D. Listen to burner operation	X			
E. Check electrical control panel on electrical heating units		X		
IX. MISCELLANEOUS				
A. Check all damper linkages and lubricate			X	
B. Check all panel door gaskets and caulk panel seams			X	
C. Check insulation on interior panels and repair as necessary			X	

LIGHTING MAINTENANCE LOG: YEAR ( )

Room Number and use	Light Level FT/C	Number and Type of Lighting Fixtures	Lamps Replaced: Quantity, Date, and Location in Room	Ballasts Replaced: Quantity, Date, and Location in Room

MOTOR CONTROLS AND MOTOR MAINTENANCE LOG: YEAR ( )

Motor Item and Use	Horse Power	Voltage and Phase	Name Plate Amps	Operating Amps		Starter				Date Corrected
				Last Year	This Year	Type	Condition	Cleaned and Tightened	Problems Found	

Annual Inspection Guidelines and Checklists

In addition to the routine maintenance programs described throughout this manual, the authors recommend a special annual inspection of all buildings and equipment. Such an inspection can be invaluable in evaluating the effectiveness of the school maintenance program and in planning and budgeting for the next year's maintenance effort.

The annual inspection suggested here is not designed to replace routine maintenance nor to supersede programs described throughout the manual.

Five separate inspection checklists are provided on the following pages. They cover the major items which must be included during the annual inspection of:

- Buildings—Exterior and Interior
- Plumbing
- Heating and Ventilating Systems
- Electrical Systems
- Fire Protection Equipment

In using these checklists for annual inspections, it is recommended that:

1) **The checklists** should serve as a starting point for developing the school district's own checklists. Lists provided here may not cover all equipment found in a school. Each school may have its own peculiar conditions.

2) **Inspection lists** should be printed and used by the inspector as guidelines in surveying building structures and equipment.

3) **The Annual Inspection** should be made in the early spring, allowing time to plan and perform all repairs during summer vacation.

4) **The inspector should** operate all equipment, such as doors, windows, faucets, flush valves, ventilators, and switches. He should look for leaking valves and faucets, items which have been improperly cleaned, and similar flaws.

5) **The inspector should** make written note of any items missing, broken, or defective. If possible, he should estimate the cost of repair (this may be added later).

6) **Sufficient time** should be allowed to make the inspection a thorough one.

ANNUAL BUILDING INSPECTION CHECKLIST

School _____

Inspector _____

Date _____

EXTERIOR MAINTENANCE	REMARKS	COST EST.
1. Roof		
Cracks		
Blisters (vapor)		
Wrinkles		
Ponding		
Gravel blown off		
Wet insulation		
Dry felts		
Foreign objects on roof		
2. Flashings and Counterflashings		
Composition flashings		
Cracks		
Open joints or end laps		
Pulled away from wall		
Metal counterflashings		
Pulled out of reglets		
Loose wedges		
Deteriorated caulking		
Rusted galvanized iron		
General deterioration		
Expansion joints		
Cracks		
Mislocated or loose blocking		
Deteriorated elastic membrane		

Building Inspection second page	**REMARKS**	**COST EST.**
2. Flashings & Counterflashings—continued		
Gravel stops and gutters		
Peeling paint		
Broken solder joints		
Separated from roof piles		
3. Skylights		
Secured to supports		
Cracks, etc.		
4. Plumbing Vents		
Vandalism		
5. Antennas, Signs, etc.		
Rust and peeling paint		
Loose guys		
Roof seal		
6. Parapets		
Open mortar joints		
Open joints in copings		
7. Chimneys		
Deteriorated brick, joints		
Flue liner		
Flashing		
8. Walls		
Cracks		
Paint condition		
Moisture (efflourescence, etc.)		
Areaways		
Caulking		
Windows (paint, etc.)		

Building Inspection third page	**REMARKS**	**COST EST.**

8. Walls—continued

Doors		
Closers		
Exit devices		
Locks and misc. hardware		

INTERIOR MAINTENANCE

1. Structural system

Rot, splitting, rust		
Termites		
Deflection		
Cracks		

2. Stairs and Handrails

Loose handrails (anchorage)		
Worn treads		
Paint or varnish, etc.		

3. Interior Walls

Cracks, bulges, etc.		
Paint conditions		
Dirt		

Building Inspection fourth page	**REMARKS**	**COST EST.**
4. Ceilings		
Cracks, bulges, etc.		
Paint condition		
Dirt		
5. Floors		
Wood		
Deteriorated areas		
Finish condition		
Resilient floor coverings		
Damaged areas		
Finish condition		
Carpet		
Stains		
Dirt		
Base		
Stains		
Dirt		
Paint condition		
6. Doors		
Closers		
Exit devices		
Hinges		
Locks and Latchsets		
Keying		
Misc. door hardware		

Building Inspection fifth page	REMARKS	COST EST.
7. Windows		
Putty and caulking		
Broken and cracked glass		
Sash operation		
Hardware		
Decay and termites		
Sills and stools, paint, etc.		
8. Shades and Blinds		
Hardware		
Blades (dirty or paint cond.)		
Fabric		
Rollers		

BUILT-IN EQUIPMENT

1. Lockers		
Hardwired		
Numbering		
Paint condition		
Doors (warped or damaged)		
2. Stage Equipment		
Curtain and backdrops		
Track, hardware, etc.		
Rigging, counter weights, etc.		
Dimmer equipment (by electrician)		
Lubricate as required		
Lighting (lamps, etc.)		
3. Auditorium Seating		
Anchorage		
Dirt		
Damage to fabric, missing parts		

Building Inspection sixth page	**REMARKS**	**COST EST.**
4. Auditorium and Gym Exits		
Exit lights		
Exit devices		
Emergency lighting		
5. Gymnasium Equipment		
Bleachers		
Damaged boards		
Lubricate as required		
Hardware		
Code requirements (if any)		
Backstops and bankboards		
Paint condition		
Loose bolts and hardware		
Motorized equipment—check and lube		
Check cables, pulleys, etc.		

ANNUAL PLUMBING INSPECTION CHECKLIST

School _____

Inspector _____

Date _____

EXTERIOR	REMARKS	COST EST.
1. Storm Drainage		
Catch basin		
Broken or missing grate		
Filled with rubbish		
Drain pipe		
Clogged		
Broken		
Areaways		
Filled with rubbish		
Broken drain		
Ground hydrants		
Sill cocks		
Downspouts		
Water valve boxes		
Gas piping		
Grease		
2.		

INTERIOR

1. Corridor		
Cleanouts		
Drinking fountains		
Electrical water coolers		

Plumbing Inspection second page	**REMARKS**	**COST EST.**
2. Toilet Room		
Water closet		
Water closet seats		
Water closet valves		
Water closet tanks		
Lavatory		
Faucet		
Drain		
Urinal		
Valve		
Tank		
Drain		
Soap		
Dispensers		
Tank		
Floor drain		
3. Kitchen		
Sink		
Faucet		
Drain		
Disposer		
Gas valves (check pilots if shut off)		
Range		
Dishwasher		

Plumbing Inspection third page	**REMARKS**	**COST EST.**
3. Kitchen—continued		
Booster heater		
Gas pilot		
Temperature (190° F)		
Flue venting		
Faucets		
Floor Drains		
4. Home Economics		
Gas valves & pilots		
Sink		
Faucet		
Drain		
Disposer		
Washer		
Faucet		
Drain		
5. Science		
Gas		
Air		
Sinks		
Faucets		
Drains		

Plumbing Inspection fourth page	REMARKS	COST EST.
6. Shop		
Gas		
Air		
Gasoline and oil interceptor		
Drains		
7. Elevator		
Drain		
Sump pump		
8. Equipment Rooms		
Drain from cooling units		
Valves		
Drains		
Sump pumps		
Sewage ejectors		
Water heaters		
Circulating pumps		
Thermometers		
Water meter		
Gas piping		
9. Roof		
Drains and downspouts		

ANNUAL HEATING AND VENTILATING INSPECTION CHECKLIST

School _____

Inspector _____

Date _____

EXTERIOR

The inspection of the exterior heating system consists of carefully noting the location and condition of the scheduled items.

Items to look for are:

1) Vandalism.
2) Badly rusted equipment and support devices requiring complete cleaning, priming and painting.
3) Masonry (chimneys) that is missing or masonry requiring tuck pointing of joints. Also masonry that is badly deteriorated by weathering or other action.
4) Damaged oil filling stations—including pipe and fittings.
5) Damaged vent piping and fittings.
6) Equipment and/or supporting devices badly rusted or broken requiring replacement of parts.
7) Oil tank corrosion.
8) Bent and otherwise damaged louvers, bird screens, exterior dampers, ventilation equipment intake or exhaust ducts.
9) Inoperable exterior dampers.
10) Roof or wall type fan operation:
    (a) Fan running;
    (b) Damper operating.
11) Relief dampers or relief vents condition.
12) Roof flashing condition at:
    (a) Roof fan units;
    (b) Duct openings;
    (c) Pipe openings.
13) Chimney condition including supports.
14) Chimney weather cap conditions.

EXTERIOR	REMARKS	COST EST.
1. Chimney & Gas Vents		
Masonry		
Metal		
Cap		
Roof flashing		
2. Roof Fan		
Fan operable		
Damper		
Roof flashing		
Bird or insect screen		
General condition		

Heating and Ventilating Inspection second page	**REMARKS**	**COST EST.**
3. Roof Relief Openings		
Roof flashing		
Damper		
General condition		
4. Duct Intake or Exhaust		
General condition		
Roof flashing		
Bird or insect screen		
External damper		
Louvers		
5. Oil Tank		
General condition		
Sludge		
Fill piping		
Vent piping		
6. Gas		
Pipe condition		
Valves		
Vent pipe		
7. Wall Fan		
General condition		
Fan running		
Damper		
Flashing		
Bird or insect screen		
8. Unit Ventilator		
Exterior louver		

Heating and Ventilating Inspection third page

INTERIOR

The inspection of the interior heating system consists of carefully noting the location and condition of the scheduled items. Special note should be taken of noisy operation, leaks, excessive dirt accumulation, non-uniform temperatures, bearing failure.

Items to look for are:

1) Vandalism.
2) Inoperative equipment.
3) Damaged equipment.
4) Missing equipment.
5) Excessive noise.
6) Excessive vibration.
7) Excessive dirt, rust or scale.

Where equipment has movable parts, they should be operated. Burners and stokers should be operated and all operating and safety controls checked for proper working condition. Pumps, fans, heating units, heating and ventilating units, etc., should all be operated by means of their normal control devices.

Controls should be checked by competent mechanics on a twice-a-year basis. Maintenance contracts with a control manufacturer are desirable. Electrical and gas apparatus should be continually checked for deterioration, leaks, etc.

Indicate the condition of the various items, location, or other identification, type of service, repair or replacement needed, estimated cost if possible.

INTERIOR	REMARKS	COST EST.
1. Boiler		
General condition		
Smoke vent and/or breeching		
Draft control damper		
Insulation		
Relief valves		
Boiler tubes		
Burner or stoker		
Controls		
Boiler feeder		
Water glass		
Combustion air intake		
Blow-down		
Water treatment		
2. Pumps		
Boiler feed pump		
General condition		
Motor		
Valves		
Tank		
Insulation		
Controls		
Pressure valve		

Heating and Ventilating Inspection fourth page	**REMARKS**	**COST EST.**
Condensate pump		
General condition		
Motor		
Valves		
Receiver		
Controls		
Circulating water pump		
General condition		
Motor		
Valves		
Controls		
3. Expansion Tank		
General condition		
Sight glass		
Water level		
4. Valves		
Leaking		
Packing		
Ease of operation		
5. Traps		
Float		
Seat		
Orifices		
6. Convectors and/or Baseboard Radiation		
General condition		
Coils, dirty		
Valves		
Trap		

Heating and Ventilating Inspection fifth page	**REMARKS**	**COST EST.**
7. Forced Flow Convectors or Fan-Coil Units		
General condition		
Coils		
Controls		
Valves		
Motor		
Belt		
Bearings		
Trap		
Fan		
8. Unit Ventilator (Steam, Water or Gas)		
General condition		
Coils, dirty		
Filter, dirty		
Motor		
Belt		
Bearings		
Fan		
Trap		
Dampers		
Controls		
Valves		
Outside air intake		
Combustion air intake		
Burner		
Gas valves & regulator		
Pilot and heat exchanger		
Vent and flashing		
9. Unit Heater (Steam, Water or Gas)		
General condition		
Coil, dirty		

Heating and Ventilating Inspection sixth page	**REMARKS**	**COST EST.**
9. Unit Heater—continued		
Motor		
Fan		
Bearings		
Valves		
Trap		
Burner		
Controls		
Belts		
Draft inducer		
Gas valve & regulator		
Pilot		
Burner and heat exchanger		
Gas vent and flashing		
10. Furnace		
General condition		
Filter, dirty		
Motor		
Belt		
Bearing		
Dampers		
Burner		
Controls		
Fan		
Gas valve & regulators		
Gas vent & flashing		
Outside air intake		
Combustion air intake		
11. Ventilating Units		
General condition		
Filter, dirty		
Motor		

Heating and Ventilating Inspection seventh page	**REMARKS**	**COST EST.**

11. Ventilating Units—continued

Sheaves		
Belt, tension and condition		
Fan		
Bearings		
Trap		
Valves		
Dampers		
Controls		
Burner		
Coils dirty		
Outside air intake		
Roof flashing		
Gas valve & regulators		
Pilot		
Burner and heat exchanger		
Gas vent and flashing		
Combustion air intake		

12. Control System

General condition		
Compressor		
Air filter—dryer		
Thermostats		
Valves & valve operators		
Summer/winter change-over switch		
Tubing or wiring condition		

ANNUAL ELECTRICAL SYSTEMS INSPECTION CHECKLIST

School _____

Inspector _____

Date _____

ELECTRICAL SYSTEMS	REMARKS	COST EST.
1. Main Service		
Inadequate capacity		
Insufficient grounding		
Obsolete wiring insulation		
Obsolete entrance equipment		
2. Distribution system		
Overloaded branch circuits		
Obsolete wiring insulation		
Insufficient receptacles		
Oversize fuses		
Excessive extension cords		
3. Lighting		
Insufficient light intensity		
Broken fixtures		
Lamp replacement		
Need for outdoor lighting		
Emergency lighting needed		
4. Special Outlets Needed for:		
Shop equipment		
Kitchen equipment		
Laboratory equipment		
Home Ec. equipment		
Arts and crafts		

Electrical Systems Inspection second page	REMARKS	COST EST.
5. Fire Alarm System		
Does not conform to School Code		
Needs maintenance		
Faulty break-glass stations		
6. Exit Signs		
Inadequate number of signs		
Need maintenance		
Lamp replacement		
7. Clock and Program System		
Inadequate number of clocks		
Inadequate program bells		
Needs maintenance		
8. Other Systems Needing Attention		
Intercommunication		
Public address		
Television		
Scoreboard		

ANNUAL FIRE PROTECTION EQUIPMENT INSPECTION CHECKLIST

School _____

Inspector _____

Date _____

FIRE PROTECTION EQUIPMENT	REMARKS	COST EST.
1. Sprinkler Systems		
Valves		
Must be O.S. & Y. type		
Must be open		
Corrosion		
Flow alarms		
Required for system with 5 or more sprinkler heads. UL approved		
Must activate building fire alarm system		
Dry pipe systems		
Check for proper air pressure in system		
Check low air pressure alarm system. Should actuate fire alarm system trouble signal		
Pressure or storage tanks		
Check for proper pressure		
Check for proper water level		
Check low pressure or low water alarm System. Should actuate fire alarm system trouble signal		
Distribution piping & sprinkler heads		
Check for leaks & corrosion		
Check for adequate hangers		

Fire Protection Equipment Inspection second page	**REMARKS**	**COST EST.**
2. Standpipe & Hose Equipment		
Hose & hose rack or cabinet		
Is hose properly stored & readily accessible?		
Is hose attached to standpipe with nozzle open & ready for use?		
Is hose serviceable without leaks, decay, etc.?		
3. Fire Extinguishers		
Check hose, nozzle, gaskets & examine for deterioration		
Check for injuries due to misuse		
Test pump action type to see if pump functions		
Test continuous-stream type by pumping up pressure and ejecting vaporizing liquid in both up-and-down and around-the-clock positions		
Test stored-pressure and CO_2 by discharging small amount of liquid or foam to atmosphere		

GENERAL COMMENTS:

Soda-acid and chemical-foam type extinguishers should be examined several times each year to see that they have not been tampered with, are not empty, have not been removed from their designated places.

Cartridge-operated type extinguishers should be inspected to see that the water level is up to the proper mark. Cartridges should be removed, examined and weighed. If there is a weight loss of 1/2 ounce or more for cartridges, they should be discarded. Other inspection procedures should be the same as for soda-acid extinguishers. Also, ensure compliance with any state or local codes regulating pressure testing.

— NOTES —

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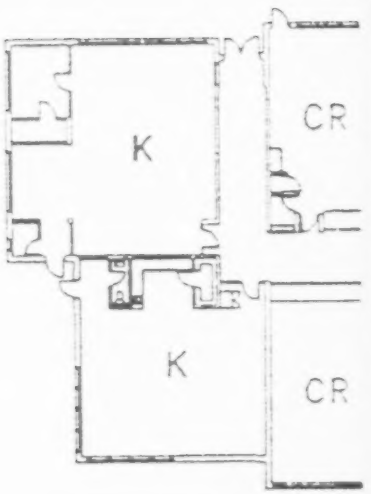

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